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WATER POLLUTION STUDIES: LOWER BEAR RIVER BASIN

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Cincinnati, Ohio

September 1956

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LOWER BEAR RIVER STUDIES

Nov.-Dec. 1955

Introduction

The studies reported here were performed at the request of the Utah and Idaho State Departments of Health jointly by those agencies and the U. S. Public Health Service. These studies were concerned with the chemical, physical and bacteriological quality of the Lower Bear River and its tributaries in the vicinity of the State line, as well as with information on waste contributing industries in the area. Field operations were conducted from November 7 through December 9, 1955.

The principal objectives of these studies were to provide:

1. Information to be used by the State of Utah in classifying certain streams.
2. Data to aid in prediction of possible future changes in stream conditions resultant from Bureau of Reclamation projects.
3. Data to aid the States involved in determining and planning suitable corrective measures.
4. Background information for planning further studies.

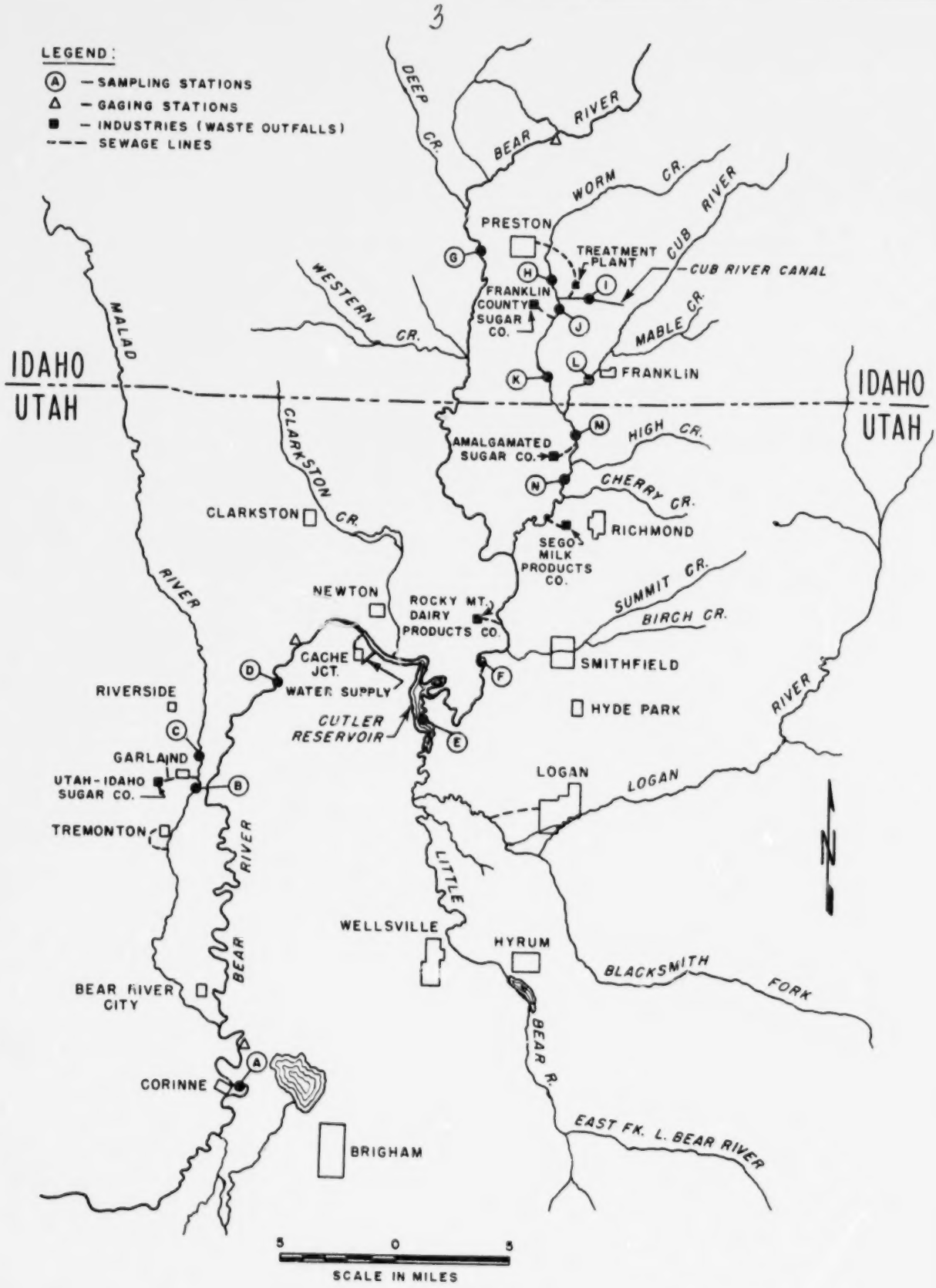
Description of Area and Waters

The Bear River rises at elevations of 12,000 feet in the Uinta Mountains in Utah, flows north into Wyoming, back into Utah, and again into Wyoming. It then enters Idaho and bears south into Utah, flowing into Bear River Bay, an arm of the Great Salt Lake. This study is concerned with the Lower Bear River Basin in the area from Preston, Idaho, to its mouth. In this region its major tributaries are the Cub River, Worm Creek, and the Malad River. A map of this area is shown in Fig. 1.

In this entire reach of the Bear River flow is regulated by irrigation diversions and returns, storage reservoirs, and power developments. Flow in the major tributaries, particularly the Cub River, is controlled to some extent. This system of flow and storage regulation results in very low summer flows, largely return irrigation, during dry years.

Irrigation is of great economic importance in the area. The principal crops grown on irrigated land include sugar beets, peas, beans, sweet corn, and potatoes. The largest single source of farm income is provided by dairy cattle dependent on irrigated pasture land.

Use of these streams for domestic water supply is of little significance at the present time. Only the community of Cache Junction, Utah, is dependent on the Bear River for its water supply which serves approximately 90 people. This water is treated for softening only. Its use to supply passenger trains was prohibited in 1934. These streams do supply some process water to most of the industries in the area. No health or operational objection to such use is known to exist.



LOWER BEAR RIVER BASIN

FIGURE 1

Recreational use of these streams is confined to fishing, principally for carp and catfish. Few, however, have been taken below Cutler Dam in recent years. Some trout were present in the past but they have reportedly been eliminated below Preston.

Wastes with little or no treatment from several municipalities and industries are received by these streams. Municipalities in this area ranging in size from 100 to 16,800 population, contribute a total BOD population equivalent of approximately 30,000. Industries in this area, principally vegetable canneries, milk plants, and beet sugar refineries, contribute a population equivalent approaching 1,000,000 during the period of sugar refining. Over 90% of this is contributed by the sugar refineries. A tabulation of industrial and domestic sources of pollution is given in Appendix F.

Potential Changes in Water Use

Future development of this region is likely to result in increased land area under irrigation and use of surface waters to supplement existing municipal supplies. Diversion of water for these purposes will also affect other water uses including dilution for waste disposal. Although not likely to be undertaken in the immediate future, at least two such projects are under consideration by the Bureau of Reclamation. These projects are the East Cache Project in Eastern Cache Valley and the Little Bear Project in Southern Cache Valley. Excerpts from Bureau of Reclamation summary reports on these projects are presented in Appendix G.

History of the Problem

A Report on Interstate Pollution in the Bear River Watershed[4] was prepared in October 1952 by the U. S. Public Health Service in cooperation with the States of Utah, Idaho, and Wyoming. This report included a general description of area and waters involved, pollution contributed, effects of pollution, a discussion of the existing authority of the States for enforcement of pollution control, and an outline of additional action needed. This report covered the entire Bear River Basin and contained a limited amount of field data on coliform organisms and effects of turbidity.

The report indicated that wastes discharged to the Bear River system likely to cause interstate pollution had an estimated population equivalent of 236,000, of which 233,000 were in the Lower Bear Basin and were discharged to the Cub River or its tributaries in Idaho within eight river miles of the Utah line. About 8% of the latter quantity was discharged one mile and 91% six miles from the State line by the California Packing Co. and Franklin Sugar Co., respectively. These discharges consisted principally of industrial wastes and received little or no treatment. The City of Preston, Idaho, eight miles from the State line, discharged the remainder of the wastes, two-thirds of which were of sewage origin, after primary treatment.

The silt burden of the Bear River contributed by return irrigation had increased, particularly in the vicinity of Preston, Idaho. This resulted in siltation of channels and reservoirs, undue wear of pump

impellers, a rise in the water table which caused bottom land to become water logged and consequently non-productive. Silt was considered to be primarily responsible for the decline of sport fishing in the past 20 years, although fish kills are believed to have resulted from beet sugar refineries discharging pulp and other wastes to the Cub River at Whitney, Idaho, and Lewiston, Utah.

The 1952 report recommended bacteriological sampling and land use evaluation be undertaken in the Lower Bear and possibly the Malad River. The States at that time had recognized this need and have subsequently organized joint bacteriological studies. A tabulation of these data is shown in Appendix B. A soil erosion control project has been placed in operation near Preston, Idaho, which has reportedly been quite effective in reducing silt originating in that area.

In February 1955, Region IX, U. S. Public Health Service, published a Report on the Investigation of Pollution in the Bear River System(5) covering the Lower Bear River Basin. This report was based on field surveys during both the vegetable canning and sugar refining seasons. It was undertaken to provide information on the effect of pollution on aquatic life in the streams.

According to this report, trout fishing is excellent on the Bear River from above Preston to the dam at Oneida, but below Preston trout have been eliminated by a combination of river bed siltation, high turbidity, and pollution. Carp and catfish have been reported from Preston to Cutler Dam. A 1954 fish population study made by the Utah Department of Fish and Game showed that fish were absent at Smithfield,

Utah, and that only a few carp were present below Cutler Dam. Mosquito fish were found at Malad. Cub River above Mapleton, Idaho, is reported to have a mediocre trout fishery, and pools above Franklin are known to support large minnow populations. Minnows and some small carp have been collected below Franklin. Fish were not found in Worm Creek.

The Bear River from Preston, Idaho, to Cutler reservoir is reportedly a virtual biological desert insofar as bottom life is concerned, as a result of excessive siltation. Below Cutler reservoir the effects of siltation on bottom organisms continue to be serious, coupled with severe effects of other pollution in the late fall. Cub River and Worm Creek support good populations of invertebrates in the upper and middle reaches but gross pollution in the lower 10-15 miles of each eliminates all but the most hardy species.

Below Preston, Idaho, phytoplankton is limited by high turbidity. Cub River and Worm Creek plankton is largely composed of attached forms which have been broken off and carried downstream by current action. Plankton blooms of forms tolerant to pollution develop each year in the lower reaches of the Cub River.

The study reported here was undertaken to supplement the bacteriological and biological data previously obtained, particularly with information on other stream characteristics.

Survey Methods

Stream Sampling Stations

Sampling stations were established, in general, above and below major sources of pollution and at intermediate locations considered of importance to show the effects of pollution in the streams. A key to the sampling stations and their locations is shown in Table 1. Figure 1 shows their locations.

Sampling Procedures

Samples were collected at approximately mid-stream and approximately mid-depth from bridges where possible. Procedures followed conventional practice and were in accordance with recommendations in Standard Methods for the Examination of Water, Sewage and Industrial Wastes, 10th Edition.(1)

For each sample taken the sample collector noted the date, time, temperature, reading of a staff gauge located in the stream at the station, and any unusual conditions present in the stream. Samples for D. O. were dosed by the sampler in the field but not titrated. Samples were transported to the lab in ice cooled cases for analysis on the same day.

Sampling Schedule

Stream samples were collected on Monday, Wednesday, Thursday, and Friday of the 5-week period from November 7 through December 9. Stations A through G were sampled on Mondays and Thursdays, and Stations H through N on Wednesdays and Fridays. Each station was therefore sampled 10 times during the survey.

TABLE 1

STREAM SAMPLING STATIONS

Station	State Designation	Approximate River Milage Above Mouth	Description
A	26	B-12	Bear R. below mouth of Malad R. near Corinne
B	28	M-12.5	Malad R. below Utah-Idaho Sugar Co.
C	27	M-14	Malad R. above Utah-Idaho Sugar Co. near Garland
D	25	B-40.5	Bear R. below Cutler Reservoir
E	24	LB-2	Little Bear R. near mouth
F	23	B-55	Bear R. below Rocky Mt. Milk Co. W. of Smithfield
G	21	B-88	Bear R. W. of Preston, Idaho
H	5	W-8	Worm Cr. above Cub R. canal
I	6		Cub R. canal above Franklin Sugar Co.
J		W-7	Worm Cr. below Cub R. canal and above Sugar Co.
K	10	W-2	Worm Cr. above state line
L	11	C-19.5	Cub R. above state line
M	16	C-12	Cub R. above Amalgamated Sugar Co.
N	22	C-10	Cub R. below Amalgamated Sugar Co.

Laboratory Facilities

All chemical and physical laboratory determinations were conducted in a mobile trailer laboratory of the U. S. Public Health Service set up at the CDC Logan Field Station, Logan, Utah. Bacteriological samples were transmitted to Salt Lake City by bus and examined in the Utah Department of Health laboratory there.

Laboratory Determinations

In the laboratory the following determinations were made on all stream samples:

1. Dissolved oxygen
2. Biochemical oxygen demand (5 day, 20° C, BOD)
3. pH (electronic pH meter)
4. Alkalinity
5. Total solids
6. Total suspended solids
7. Settleable solids (Imhoff cones)
8. Turbidity (candle turbidimeter)
9. Coliform organisms (MPN)

All analyses were made in accordance with Standard Methods for the Examination of Water, Sewage and Industrial Wastes, 10th Edition.(1)

Flow Measurements

Stream discharge data was supplied by the Logan office of the U.S.G.S. Partial rating curves were developed by them for the range of flows encountered so that from the staff gauge readings taken during the survey and a few continuous recording gauges discharges could be computed.

Special Procedures for Industrial Surveys

Special sampling, gauging and analytical procedures employed in the industrial waste surveys are described for each plant in the detailed report on that plant in Appendix E.

Presentation of Data

A summary of stream data is given in Table 2. A complete tabulation of individual results is given in Appendix A. Other pertinent stream data are given in Appendices B through D.

A summary of waste loads contributed by the industries investigated during this survey is given in Table 3. A complete tabulation of results is presented in the reports of individual plant surveys in Appendix E.

Table 2

SUMMARY OF DATA

STATION No.	Description		TEMP. (°C)	RATE OF FLOW (cfs) At Samp. Time	Mean Daily	SOLIDS (ppm) Total	Susp.	Settleable m/l	pH	ALKALINITY (ppm) Phenolphthalein	Total	TURB. (ppm)	D. O. (ppm)	% SAT.	BIOCHEMICAL OXYGEN DEMAND (ppm)	#/da. at sampling time Flow	#/da. mean daily Flow	COLIFORMS (MPN/100ml)	
A	Bear R. below mouth of Malad R. near Corinne	Max.	8	1910	1850	1000	51.6	0.1	8.3	0	326	40	10.30	70.5	21.4	188,000	181,000	93,000	
		Min.	0	850	870	677	13.2	Trace	8.0	0	244	20	6.00	48.9	3.17	25,100	27,100	1,500	
		Mean	2.1	1350	1360	845	28.9	Trace	8.1	0	305	30	8.07	58.3	12.6	94,200	94,200	18,000	•
B	Malad R. below Utah-Idaho Sugar Co.	Max.	10	100	-	4480	2110	23.	10.9	276	1720	900	10.21	71.7	345	105,800	-	> 230,000	
		Min.	0	57.0	-	2600	88.8	0.17	8.1	0	350	55	6.01	51.9	26.3	11,260	-	23	
		Mean	5.2	77.1	-	3280	818	4.7	8.6	33.6	748	400	7.82	61.7	157	62,020	-	93,000	•
C	Malad R. above Utah-Idaho Sugar Co. near Garland	Max.	8.5	81.5	-	2970	66.5	< 0.1	8.2	0	388	70	10.80	76.7	1.00	422.3	-	2,300	
		Min.	0	42.0	-	2220	10.4	Trace	8.0	0	282	10	9.00	66.4	0.57	151.5	-	43	
		Mean	3.0	60.8	-	2540	33.0	Trace	8.1	0	357	35	9.84	73.4	0.79	262.7	-	330	•
D	Bear R. below Cutler Reservoir	Max.	5	2220	1660	574	22.0	< 0.1	8.3	0	318	35	11.13	76.1	15.0	110,900	114,500	93,000	
		Min.	0	100	480	498	0.4	0	8.0	0	231	4	5.94	45.2	2.85	490.5	18,550	93	
		Mean	1.7	1170	1240	528	7.6	Trace	8.1	0	295	10	8.24	53.2	8.90	48,320	59,050	9,300	•
E	Little Bear R. near mouth	Max.	5	-	-	344	36.0	Trace	8.2	0	246	50	13.72	93.8	1.19	-	-	9,300	
		Min.	0	-	-	292	0.4	0	8.0	0	179	3	9.95	71.9	0.63	-	-	43	
		Mean	1.7	-	-	316	11.1	Trace	8.1	0	227	20	11.71	84.0	0.90	-	-	430	•

Table 2 (Continued)

SUMMARY OF DATA

STATION No.	Description		TEMP. (°C)	RATE OF FLOW (cfs) At Samp. Time	Mean Daily	SOLIDS (ppm) Total	Susp.	Settle-able m/l	pH	ALKALINITY (ppm) Phenol-phthal-ein	Total	TURB. (ppm)	D. O. (ppm)	% SAT.	BIOCHEMICAL OXYGEN DEMAND (ppm	#/da. at sampling time Flow	#/dc. mean daily Flow	COLIFORMS (MPN/100ml)	
F	Bear R. below Rocky Mt. Milk Co. West of Smithfield	Max.	6	840	1500	721	102	0.1	8.3	0	359	85	10.86	77.35	18.3	74,800	94,450	93,000	
		Min.	0	570	650	589	12.2	Trace	8.1	0	262	30	8.79	65.2	1.56	12,340	10,910	230	
		Mean	1.7	723	950	645	49.3	<0.1	8.2	0	337	50	9.95	71.1	9.91	40,470	49,690	6,800	•
G	Bear R. West of Preston, Idaho	Max.	6	600	650	994	46.4	<0.1	8.2	0	357	100	12.09	82.7	1.70	4,000	4,616	930	
		Min.	0	135	310	580	8.0	Trace	7.7	0	265	7	9.14	69.8	0.68	878	1,553	93	
		Mean	2.1	316	456	676	20.7	Trace	8.1	0	333	25	10.41	75.2	1.20	2,018	2,837	93	•
H	Worm Creek above Cub R. Canal	Max.	4	4.5	-	594	218	0.2	8.3	0	360	230	10.95	75.4	4.51	77.7	-	43,000	
		Min.	0	1.0	-	454	26.	Trace	8.0	0	308	25	8.37	63.7	0.87	9.69	-	230	
		Mean	2.3	3.1	-	520	114	<0.1	8.1	0	326	140	9.92	72.1	2.21	38.2	-	15,000	
I	Cub R. Canal above Franklin Sugar Co.	Max.	4	22.4	-	249	14.2	Trace	8.1	0	202	15	11.48	82.9	1.19	96.1	-	230,000	
		Min.	0	0.5	-	197	3.4	0	8.0	0	164	2	9.54	65.4	0.22	26.5	-	230	
		Mean	2.3	13.4	-	219	7.0	Trace	8.1	0	180	7	10.33	75.1	0.72	60.9	-	2,300	•
J	Worm Creek below Cub R. Canal and above Sugar Co.	Max.	10	14.7	-	533	138	0.1	8.1	0	322	160	10.76	74.0	5.05	258.0	-	230,000	
		Min.	0	6.0	-	205	4.0	0	8.0	0	176	5	8.11	65.0	1.07	61.0	-	930	
		Mean	3.2	10.1	-	321	40.1	Trace	8.0	0	226	45	9.65	71.6	2.81	143.9	-	4,300	•
K	Worm Creek above State line	Max.	10	27.0	-	2410	1520	11	7.9	0	1070	1400	6.47	44.3	617	54,800	-	4,300,000	
		Min.	0	14.5	-	585	47.5	Trace	7.6	0	356	70	0.04	0.34	45.5	4,990	-	750	
		Mean	4.6	20.0	-	1280	543	3.7	7.8	0	621	600	3.18	23.4	204	25,910	-	430,000	•

Table 2 (Continued)

SUMMARY OF DATA

STATION No.	Description		TEMP. (°C)	RATE OF FLOW (cfs) At Samp. Time	Mean Daily	SOLIDS (ppm) Total	Susp.	Settleable m/l	pH	ALKALINITY (ppm) Phenolphthalein	Total	TURB. (ppm)	D. O. (ppm)	% SAT.	BIOCHEMICAL OXYGEN DEMAND (ppm)	#/da. at sampling time Flow	#/da. mean daily Flow	COLIFORMS (MPN/100ml)
L	Cub R. above State line	Max.	4	18.3	-	346	17.0	Trace	8.2	0	255	10	11.14	82.0	1.32	86.6	-	43,000
		Min.	0	4.0	-	290	3.8	0	8.0	0	221	3	8.78	66.9	0.50	17.14	-	230
		Mean	2.0	9.6	-	315	9.2	Trace	8.1	0	237	8	10.22	73.7	0.80	41.75	-	330 *
M	Cub R. above Amalgamated Sugar Co.	Max.	7	47.0	-	728	232	0.5	8.0	0	476	250	7.99	54.7	380	45,900	-	2,300,000
		Min.	0	2.0	-	449	14.4	Trace	7.6	0	310	25	0.00	0	19.6	8,220	-	930
		Mean	3.1	32.9	-	706	111	0.1	7.8	0	385	150	3.60	25.9	162	27,480	-	163,000 *
N	Cub R. below Amalgamated Sugar Co.	Max.	10	78.0	-	1250	45.0	0.2	7.8	0	395	130	9.41	64.4	670	223,400	-	9,300,000
		Min.	0	15.0	-	460	10.0	Trace	7.2	0	309	20	2.33	11.7	30.4	24,500	-	430
		Mean	4.7	56.2	-	816	24.2	Trace	7.6	0	351	75	3.83	28.6	309	98,630	-	230,000 *

* Median rather than Mean.

TABLE 3

SUMMARY OF INDUSTRIAL WASTE LOADS

Industry	Mean Daily Production For 1955 (Tons Beets sliced per day)	#BOD/ Ton Beets	#BOD/Day	Population Equivalent
Utah-Idaho Sugar Co.	1840	25	46,000*	271,000
Franklin Co. Sugar Co.	1331	48.5	64,554*	379,730
Amalgamated Sugar Co.	1594	36.2	57,703*	339,430
SEGO Milk Co.			103.2**	607
Rocky Mt. Dairy Products Co.			1207***	7,100

* Based on Mean Daily 1955 Production

** Mean During Survey

*** One Day Of Survey Of Both Bottling And Cheese Making

DISCUSSION OF DATA

Biochemical Oxygen Demand

Figure 2 is a diagramatic representation of the mean concentrations of BOD observed during this study at various points in the Lower Bear River system. In the main stem of the Bear River at Station G above all major sources of pollution the mean BOD was only 1.20 ppm and the mean total passing that point 2,018 pounds daily. At Station F below the confluence with the Cub River and below most of the major sources of pollution the mean BOD was 9.91 ppm and 40,470 pounds daily. Below the confluence with the Little Bear River and below Cutler Reservoir at Station D the mean concentration was reduced slightly to 8.90 ppm but the mean daily total increased to 48,320 pounds. At Station A, 12 miles above the mouth and below the confluence with the Malad River carrying Garland sewage and Utah-Idaho Sugar Company waste, the mean BOD had increased to 12.6 ppm and 94,200 pounds daily.

In the Cub River above major sources of pollution at Station L the mean BOD concentration was only 0.80 ppm and mean daily total only 41.75 pounds daily. At Station M below the confluence with Worm Creek carrying Preston sewage and waste from the Franklin County Sugar Company and just above the Amalgamated Sugar Company outfalls the mean BOD was 162 ppm and 27,480 pounds. Just below the Amalgamated Sugar Company at Station N the mean BOD was 309 ppm and 98,630 pounds. An accumulation of 71,150 pounds of BOD is therefore indicated for the approximately two mile stretch of river passing the Amalgamated Sugar Company. This is slightly higher than the 57,703 pounds discharged daily by the plant.

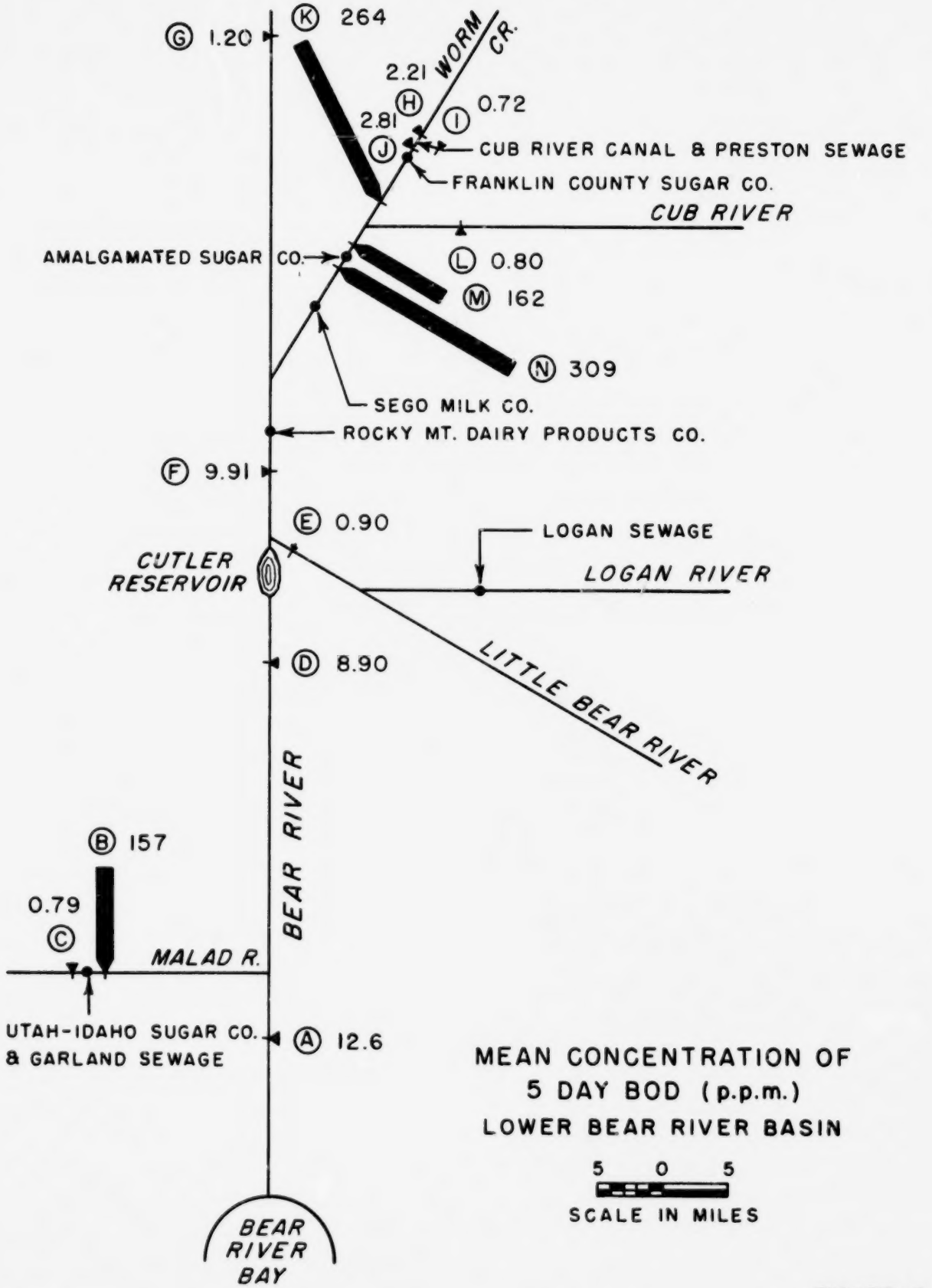

Ⓚ 264
Ⓖ 1.20
2.21 WORM CR.
Ⓗ
Ⓘ 0.72
2.81
Ⓙ
CUB RIVER CANAL & PRESTON SEWAGE
FRANKLIN COUNTY SUGAR CO.
CUB RIVER
AMALGAMATED SUGAR CO.
Ⓛ 0.80
Ⓜ 162
Ⓝ 309
SEGO MILK CO.
ROCKY MT. DAIRY PRODUCTS CO.
Ⓕ 9.91
Ⓔ 0.90
LOGAN SEWAGE
CUTLER RESERVOIR
LOGAN RIVER
LITTLE BEAR RIVER
Ⓓ 8.90
BEAR RIVER
Ⓑ 157
0.79
Ⓒ
MALAD R.
UTAH-IDAHO SUGAR CO. & GARLAND SEWAGE
Ⓐ 12.6
BEAR RIVER BAY
MEAN CONCENTRATION OF
5 DAY BOD (p.p.m.)
LOWER BEAR RIVER BASIN
5 0 5
SCALE IN MILES

FIGURE 2

Worm Creek above major sources of pollution had a mean BOD of 2.21 ppm and 38.2 pounds daily at Station H just above the point at which Cub River Canal enters. At Station J just below the entry of the Cub River Canal and Preston sewage and just above the Franklin County Sugar Company the mean BOD was 2.81 ppm and 143.9 pounds daily. The Cub River Canal had a BOD of 0.72 ppm and 60.9 pounds daily at Station I, approximately a mile from Worm Creek. A total load of 45.2 pounds is indicated for Preston sewage as compared with an estimated total of 442 pounds (for a population equivalent of 2,600). No explanation for the discrepancy is apparent. Station K approximately 4 miles below the Franklin County Sugar Company had a mean BOD of 264 ppm and 25,910 pounds daily. An increase of 25,766 pounds of BOD is therefore indicated for the 5 miles between Stations J and K as compared with a contribution by the plant of 64,554 indicated by the plant survey.

At Station E on the Little Bear River just above its confluence with the Bear River a mean BOD of 0.90 ppm was observed. This Station is 14 stream miles below the point of discharge of Logan sewage. The total pounds of BOD passing Station E could not be calculated because discharge data could not be obtained.

On the Malad River at Station C just above the Garland sewage and Utah-Idaho Sugar Company outfalls the mean BOD was 0.79 ppm and 262.7 pounds. At Station B just below the outfalls the mean BOD was 157 ppm and 62,020 pounds daily. A total contribution of 61,757 is indicated as compared with a survey value of 46,000 pounds daily for the plant and an estimated contribution of 153 pounds daily for the city, (Population 900).

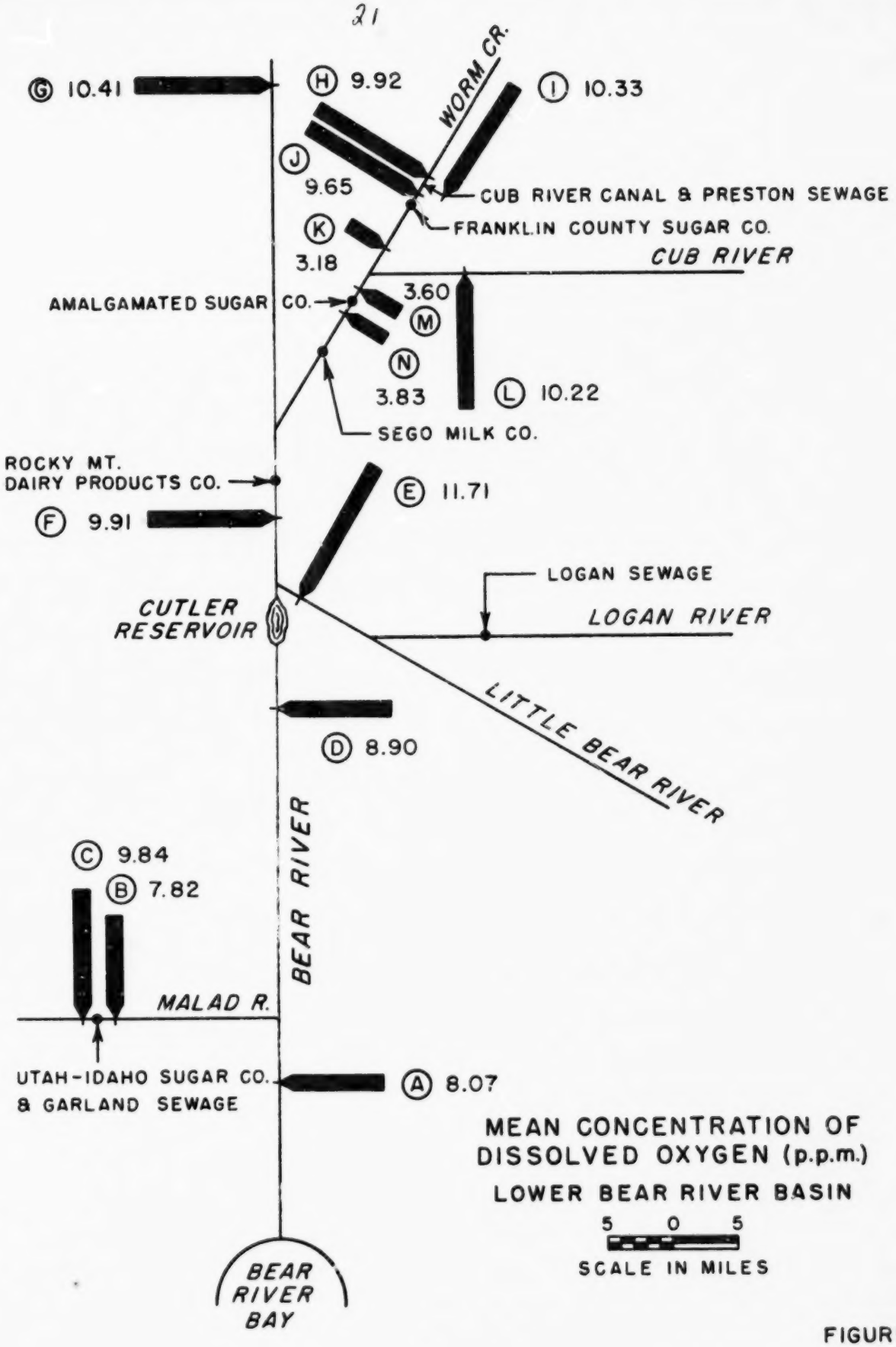

G 10.41
H 9.92
WORM CR.
I 10.33
J 9.65
CUB RIVER CANAL & PRESTON SEWAGE
FRANKLIN COUNTY SUGAR CO.
K 3.18
CUB RIVER
AMALGAMATED SUGAR CO.
3.60
M
N 3.83
L 10.22
SEGO MILK CO.
ROCKY MT. DAIRY PRODUCTS CO.
E 11.71
F 9.91
LOGAN SEWAGE
CUTLER RESERVOIR
LOGAN RIVER
LITTLE BEAR RIVER
D 8.90
BEAR RIVER
C 9.84
B 7.82
MALAD R.
UTAH-IDAHO SUGAR CO. & GARLAND SEWAGE
A 8.07
BEAR RIVER BAY
MEAN CONCENTRATION OF DISSOLVED OXYGEN (p.p.m.)
LOWER BEAR RIVER BASIN
5 0 5
SCALE IN MILES

FIGURE 3

From these data it is apparent that the sections of very high BOD concentration occur, as might be expected, just below the Sugar refineries. Considerable fluctuations in BOD concentrations and total loads were also observed from day to day, particularly at stations below these plants. Results at these stations varied by as much as a factor of 10 during the course of the study.

BOD fluctuations and discrepancies between loads observed in the stream and by plant surveys may be partially explained by the difficulty in obtaining representative samples due to the presence of high concentrations of solids below the plants. Possible fluctuations in stream discharge throughout the day due to irrigation diversions, particularly in Cub River and Worm Creek, may also have been a factor. In any case, plant survey results are considered a more reliable measure of actual plant loads than inferences drawn from stream data.

Dissolved Oxygen

Figure 3 shows the mean concentration of D.O. at various stations for the period of the survey. D.O. concentrations ranged from 8.07 ppm to 11.71 ppm in the entire system except immediately below the sugar refineries. Stations K and M below the Franklin Company plant and Station N below both the Franklin Company and Amalgamated plants had mean D.O. concentrations of 3.18, 3.60, and 3.83 ppm respectively. Station B immediately below the Utah-Idaho Sugar Company had a D.O. of 7.82 ppm. The close proximity of this station to the plant may have prevented observation of the maximum oxygen depletion. An additional station closer to the mouth of the Malad River would be desirable in any future study. The minimum dissolved oxygen observed was well above 5.

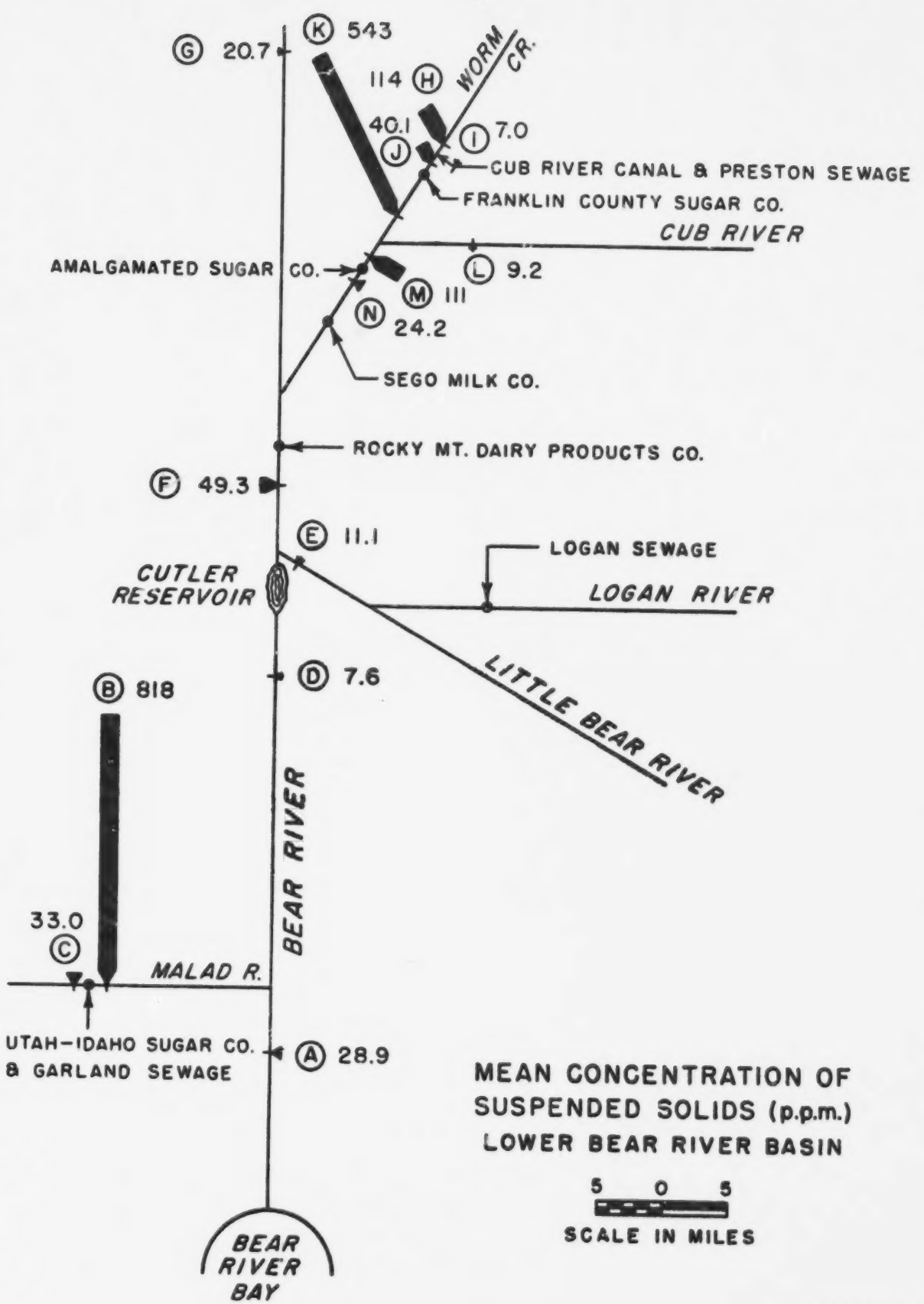

G 20.7
K 543
114 H
WORM CR.
40.1 J
I 7.0
CUB RIVER CANAL & PRESTON SEWAGE
FRANKLIN COUNTY SUGAR CO.
CUB RIVER
AMALGAMATED SUGAR CO.
L 9.2
M 111
N 24.2
SEGO MILK CO.
ROCKY MT. DAIRY PRODUCTS CO.
F 49.3
E 11.1
LOGAN SEWAGE
CUTLER RESERVOIR
LOGAN RIVER
LITTLE BEAR RIVER
D 7.6
B 818
BEAR RIVER
33.0 C
MALAD R.
UTAH-IDAHO SUGAR CO. & GARLAND SEWAGE
A 28.9
BEAR RIVER BAY
MEAN CONCENTRATION OF SUSPENDED SOLIDS (p.p.m.) LOWER BEAR RIVER BASIN
5 0 5
SCALE IN MILES

FIGURE 4

ppm except for Stations N, M, and K. Station M did reach 0 ppm on November 11 and Station K 0.04 ppm on November 9.

From these data it would appear that dissolved oxygen is present during the sugar refining campaign in more than critical amounts except in those portions of Cub River and Worm Creek between the Franklin County Sugar Co. and the Bear River. In portions of those streams D.O. may be entirely depleted.

Suspended Solids

The mean concentrations of suspended solids during the survey are shown in Figure 4. In most of the system mean suspended solids ranged from 7.0 ppm to 49.3 ppm. At only four stations were appreciably higher mean concentrations observed.

At Station H above major sources of pollution a mean concentration of 114 ppm was observed which appears somewhat higher than might be expected. At Station K below the Franklin County Sugar Company plant a mean concentration of 543 ppm was observed. This represents an increase of over 500 ppm in the five miles between Stations J and K in spite of an increase in mean stream discharge from 10.1 cfs at Station J to 20.0 cfs at K. This increase in solids concentration is undoubtedly attributable to a solids loss at the plant.

The mean solids concentration at Station M just above the Amalgamated Sugar Company, below the Franklin County plant, and below the confluence of Cub River and Worm Creek was reduced to 111 ppm. At Station N just below the Amalgamated Sugar Company plant the mean concentration was further reduced to 24.2 ppm. This would indicate an apparent

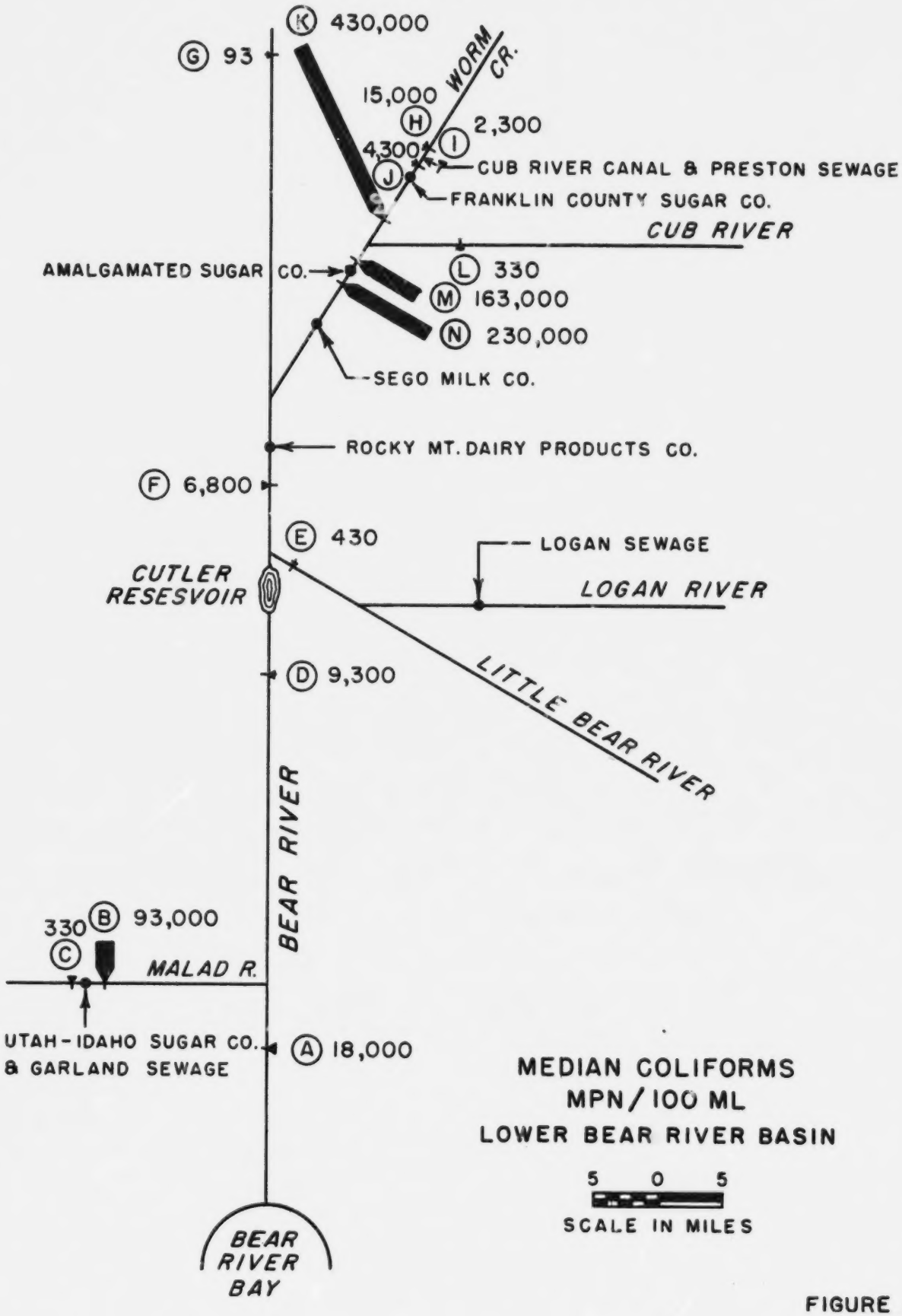

(K) 430,000
(G) 93
WORM CR.
15,000
(H)
2,300
(I)
4,300
(J)
CUB RIVER CANAL & PRESTON SEWAGE
FRANKLIN COUNTY SUGAR CO.
CUB RIVER
AMALGAMATED SUGAR CO.
(L) 330
(M) 163,000
(N) 230,000
SEGO MILK CO.
ROCKY MT. DAIRY PRODUCTS CO.
(F) 6,800
(E) 430
LOGAN SEWAGE
CUTLER RESESVOIR
LOGAN RIVER
(D) 9,300
LITTLE BEAR RIVER
BEAR RIVER
330
(B) 93,000
(C)
MALAD R.
UTAH-IDAHO SUGAR CO. & GARLAND SEWAGE
(A) 18,000
BEAR RIVER BAY
MEDIAN COLIFORMS
MPN/100 ML
LOWER BEAR RIVER BASIN
5 0 5
SCALE IN MILES

FIGURE 5

solids reduction in the two mile stretch of river passing the plant of 12,330 pounds. The plant survey, however, indicates that the plant contributes an average of 123,500 pounds of solids. On the basis of plant solids loss alone a suspended solids concentration of 407 ppm at Station N is indicated. No explanation for the stream observations is apparent. It does not seem likely that sedimentation in the mile between the plant and Station N could account for all of the solids reduction.

At Station B just below the Utah-Idaho Sugar Company plant a mean suspended solids concentration of 818 ppm was observed as contrasted with 33.0 ppm at Station C just above the plant. A solids increase of 329,300 pounds is therefore indicated. This compares reasonably well with the mean daily suspended solids loss of 402,560 pounds during the plant survey. The higher solids loss during the plant survey may be partially explained by the malfunctioning of the lime pond which is not necessarily typical of plant operation.

Coliforms

The median most probable numbers of coliform organisms per 100 ml for stream samples collected during the survey are shown in Figure 5. High MPNs were observed only in tributary streams receiving both sewage and sugar refinery waste.

At Station J below the point of discharge of Preston sewage the median MPN was only 4,300 while 5 miles downstream below the Franklin County Sugar Company plant at Station K the median MPN was 430,000. Similarly at Station M below the Franklin County plant and above the

Amalgamated Sugar Company plant the MPN was 163,000 while below the Amalgamated plant it was 230,000. On the Malad River between Stations C and B where Garland sewage and Utah-Idaho Sugar Company waste are discharged the median MPN increased from 330 to 93,000. The Little Bear River at Station E 14 miles from the point of discharge of Logan sewage had a median MPN of only 430.

These data do not indicate higher than anticipated MPNs for the population load at Preston and Garland. It is possible, however, that the sugar refinery waste may influence the MPN by serving as nutrient for the organisms. Both Stations K and M showed considerably higher MPNs during this survey than previous surveys when the refineries were not in operation.

Other Determinations

Stream temperatures were generally low ranging from 0° to 10°C. The mean temperatures ranged from 1.7° to 5.2°C. with the highest mean temperatures occurring below the sugar refineries.

Stream discharges showed considerable fluctuation. In the main stem of the Bear River where continuous records are available these records showed less variation in the mean daily discharge from day to day than the instantaneous observations. At the time of sampling, discharge at Station E on Little Bear River could not be measured because of large and sudden fluctuations at that point. Discharge at that point is a function of supply from Bear and Little Bear Rivers, draught at the Cutler plant, and effect of evaporation and transpiration which is significant with a full reservoir and no draught at Cutler.

The mean pH ranged from 7.6 to 8.6. On only one occasion, below the Utah-Idaho Sugar Company at Station B when that plant was having difficulty in controlling its lime pond, did the pH get excessively high (10.9).

PROPOSED BUREAU OF RECLAMATION PROJECTS

Any proposed changes in water use must be considered in the light of the effect such changes will have on other water uses. Diversion of water for irrigation or supplemental municipal supplies could cause reduction in flows sufficient to result in nuisance conditions or the necessity to provide additional industrial or domestic waste treatment. Future use of surface waters for municipal supplies may require application of different quality criteria and result in the necessity for additional waste treatment. Increased irrigation could serve to increase silt conditions and related problems.

Accurate determination of the effects of such changes in water use cannot be made without detailed knowledge of the extent of such changes and their effect on stream flows. Since this information is not available for the projects presently under consideration and since no immediate action on these projects is likely, a detailed analysis of the probable effects of these projects will not be attempted here.

Some general statements relative to these projects can be made, however. The proposed East Cache project would affect stream flows in both the Cub River and Worm Creek as well as the Bear River. The entire area covered in the studies reported here would be influenced to some extent. A re-evaluation of stream quality requirements for this entire area will be required when plans for this project have been developed sufficiently to supply the requisite data. In addition, if surface waters are to be employed to supplement municipal supplies for Lewiston and other communities these waters will have to be investigated to

determine their suitability. The Little Bear project will influence flows in the Logan, Little Bear, and Bear Rivers. When detailed information on this project is available re-evaluation of the portions of those streams affected may be indicated. Particular consideration may be required at that time to the necessity for treatment of Logan sewage. Surface water supply sources for Logan and River Heights will also warrant investigation.

APPENDIX A

TABULATION OF STREAM SURVEY DATA

Table A-1

TABULATION OF STREAM SURVEY DATA

STATION No.	STATION Description	DATE	TIME	TEMP °C	RATE OF FLOW (cfs) (d)	RATE OF FLOW (cfs) (e)	SOLIDS (ppm) Total	SOLIDS (ppm) Susp.	SOLIDS (ppm) Settleable m/l.	pH	ALKALINITY ppm Phenol.	ALKALINITY ppm Total	TURB ppm	D. O. ppm	D. O. % Sat.	B. O. D. ppm	B. O. D. #/day	COLIFORMS (MPN/100ml)
A	Bear R. below mouth of Malad R. near Corinne	11-7	10:30A	5	850	870	978	31.6	<0.1	8.1	0	244	40	7.94	62.0	13.0	59,400	60,800 / 23,000
		11-10	9:20A	8	1020	1030	1000	29.2	<0.1	8.1	0	290	35	6.00	50.5	10.0	54,800	55,400 / 21,000
		11-16	12:00M	0	1270	1320	902	13.2	Trace	8.2	0	294	40	(a)	-	17.6	120,300	125,000 / 93,000(c)
		11-18	10:15A	0	1310	1360	911	20.0	Trace	8.2	0	326	30	8.73	59.7	21.4	150,800	156,500 / 23,000
		11-23	10:50A	0	1910	1840	759	27.2	Trace	8.3	0	315	35	8.54	58.4	18.3	188,000	181,000 / 15,000
		11-25	10:15A	2	1820	1850	677	51.6	0.1	8.1	0	309	35	8.24	59.5	14.6	143,000	145,300 / 15,000(c)
		11-30	10:45A	3	1450	1370	788	25.8	<0.1	8.0	0	319	30	6.59	48.9	11.3	88,200	83,300 / 46,000
		12-2	10:55A	3	1370	1310	839	17.2	Trace	8.0	0	324	20	6.60	48.9	10.8	79,600	76,100 / 1,500
		12-7	10:50A	0	1060	1010	863	30.4	Trace	8.3	0	309	20	9.70	66.3	5.80	33,100	31,500 / 9,300
		12-9	10:05A	0	1470	1590	733	42.4	<0.1	8.1	0	317	35	10.30	70.5	3.17	25,100	27,100 / 2,300
B	Malad R. below Utah-Idaho Sugar Co.	11-7	10:00A	10	68.5		2980	603	1.7	8.6	21.4	622	320	7.29	64.3	167		61,600 / 43,000
		11-10	9:55A	10	65.5		2600	246	0.6	8.1	0	350	200	6.93	61.2	115		40,500 / 93,000
		11-16	11:15A	0	57.0		4480	2110	23	10.9	276	1720	900	(a)	-	345		105,800 / 23(c)
		11-18	9:30A	3	60		3340	795	1.7	8.5	1.20	924	450	7.57	56.16	219		70,700 / 93,000
		11-23	10:20A	4	80		3290	877	1.5	8.5	11.6	733	600	7.70	58.6	140		60,200 / 93,000
		11-25	9:45A	6	89.5		3430	1230	3.0	8.4	8.40	888	600	7.65	61.2	156		75,100 / 43,000(c)
		11-30	10:20A	9	100		3730	1430.0	9.0	8.5	13.6	976	650	6.01	51.9	157		84,500 / 230,000
		12-2	10:05A	7	98.0		2640	380	3.0	8.4	4.20	465	250	7.75	63.7	92.0		48,500 / 43,000
		12-7	10:10A	2	79.5		3210	417	2.	8.3	0	396	85	9.25	66.8	26.3		11,260 / 110,000
		12-9	10:35A	1	72.5		3130	88.8	0.17	8.1	0	402	55	10.21	71.7	> 87.0		> 33,900 / 230,000 +
C	Malad R. above Utah-Idaho Sugar Co. nr. Garland	11-7	9:15A	6	54.5		2640	30.8	<0.1	8.1	0	282	40	9.21	73.8	1.00		293.2 / 230
		11-10	9:30A	8.5	50.0		2570	41.2	<0.1	8.1	0	336	40	9.00	76.7	0.78		210.0 / 230
		11-16	10:45A	0	42.0		2970	10.4	Trace	8.1	0	334	10	(a)	-	0.67		151.5 / 430(c)
		11-18	9:10A	0	45		2710	26.4	Trace	8.0	0	360	30	9.71	66.4	0.79		191.2 / 930
		11-23	10:00A	1	65		2410	27.6	Trace	8.1	0	352	35	10.61	74.6	0.72		252.0 / 430
		11-25	9:10A	2	72.5		2350	27.2	Trace	8.2	0	365	20	10.29	73.3	0.81		316.0 / 230(c)
		11-30	10:00A	6	81.5		2430	66.5	<0.1	8.2	0	370	70	9.21	73.8	0.83		364.0 / 930

Table A-1 (Continued)

TABULATION OF STREAM SURVEY DATA

STATION No.	STATION Description	DATE	TIME	TEMP °C	RATE OF FLOW (cfs) (d)	RATE OF FLOW (cfs) (e)	SOLIDS (ppm) Total	SOLIDS (ppm) Susp.	SOLIDS (ppm) Settleable m/l.	pH	ALKALINITY ppm Phenol.	ALKALINITY ppm Total	TURB ppm	D. O. ppm	D. O. % Sat.	B.O.D. ppm	B.O.D. #/day	COLIFORMS (MPN/100ml)
C (continued)		12-2	9:45A	4.5		78.5	2220	37.6	Trace	8.2	0	364	40	9.25	71.4	1.00	422.3	2,300
	Malad R.	12-7	9:50A	1		62.5	2400	29.6	Trace	8.1	0	368	30	10.50	73.8	0.76	255.5	210
	above	12-9	10:15A	1		56.0	2730	32.4	Trace	8.2	0	388	35	10.80	75.9	0.57	171.7	43
	utah-Idaho Sugar Co. nr.Garland																	
D	Bear R. below Cutler Reservoir	11-7	8:45A	4.5	613	1100	518	4.4	Trace	8.0	0	231	9	7.75	59.8	6.38	20,970	37,800	43,000
		11-10	9:00A	5	600	480	550	22	< 0.1	8.1	0	280	35	6.60	51.6	9.48	15,300	24,500	93,000
		11-16	10:15A	0	100	960	574	8.4	0	8.3	0	289	7	(a)	-	15.0	4,032	77,500	43,000(c)
		11-18	8:30A	0	600	1550	498	0.4	Trace	8.2	0	296	6	8.69	59.4	10.5	31,100	87,600	23,000
		11-23	9:00A	0	1380	1600	514	4.6	Trace	8.1	0	293	15	11.13	76.1	13.3	110,900	114,500	4,300
		11-25	8:30A	0	2220	1660	527	4.0	Trace	8.1	0	310	8	7.97	54.5	7.12	85,100	63,600	9,300(c)
		11-30	9:00A	4	1160	1300	536	6.0	Trace	8.0	0	311	6	5.94	45.2	9.75	60,800	68,200	9,300
		12-2	9:10A	3	1900	1240	545	16.4	Trace	8.0	0	315	15	7.31	54.2	10.8	110,400	72,000	4,300
		12-7	9:15A	0	1000	1210	498	4.6	0	8.1	0	306	5	9.14	62.5	2.85	490.5	18,550	430
		12-9	9:25A	0	2150	1280	519	5.0	0	8.2	0	318	4	9.60	65.7	3.81	44,070	26,220	93
E	Little Bear R. near mouth	11-7	8:00A	5			307	18.4	Trace	8.2	0	179	30	11.50	89.8	0.89			93
		11-10	8:25A	4.5			317	25.2	Trace	8.1	0	210	40	10.41	80.3	1.17			43
		11-16	9:00A	0			304	2.8	Trace	8.2	0	228	5	(a)	-	0.68			9,300(c)
		11-18	7:55A	0			300	0.4	Trace	8.1	0	230	4	12.36	84.5	0.94			430
		11-23	8:30A	0			292	1.0	Trace	8.2	0	217	4	11.13	76.1	0.88			230
		11-25	7:45A	1			336	5.2	0	8.1	0	236	9	13.03	91.6	1.12			4,300(c)
		11-30	8:20A	4			336	16.0	Trace	8.0	0	239	30	10.98	83.6	0.77			430
		12-2	8:30A	2			344	36.0	Trace	8.1	0	240	50	9.95	71.9	1.19			430
		12-7	8:35A	0			314	4.2	0	8.1	0	240	4	12.27	83.9	0.75			430
		12-9	8:30A	0			314	2.2	Trace	8.2	0	246	3	13.72	93.8	0.63			43

Table A-1 (Continued)

TABULATION OF STREAM SURVEY DATA

STATION No.	STATION Description	DATE	TIME	TEMP °C	RATE OF FLOW (d)	RATE OF FLOW (e)	SOLIDS (ppm) Total	SOLIDS (ppm) Susp.	SOLIDS (ppm) Settleable m/l.	pH	ALKALINITY ppm Phenol.	ALKALINITY ppm Total	TURB ppm	D. O. ppm	D. O. % Sat.	B. O. D. ppm	B. O. D. #/day	COLIFORMS (MPN/100ml)
F	Bear R. below Rocky Mt. Milk Co. West of Smithfield	11-7	7:30A	5	570	800	654	32.8	<0.1	8.2	0	262	40	9.35	73.0	15.4	47,240	66,300	93,000
		11-10	8:00A	6	600	900	650	61	0.1	8.2	0	318	45	8.79	70.4	15.9	51,300	77,000	43,000
		11-16	8:30A	0	-	1300	608	28	Trace	8.2	0	339	35	10.71	73.3	1.56	-	10,910	9,300(c)
		11-18	7:30A	0	-	-	721	12.2	Trace	8.1	0	348	30	9.53	65.2	15.9	-	-	93,000
		11-23	8:00A	0	-	1500	674	102	0.1	8.1	0	354	85	9.68	66.2	11.7	-	94,450	23,000
		11-25	7:10A	0	-	1000	650	74.8	<0.1	8.2	0	359	65	10.86	74.3	10.3	-	55,400	4,300(c)
		11-30	7:45A	4	760	750	677	52.4	<0.1	8.2	0	348	55	9.07	69.1	18.9	74,800	73,800	4,300
		12-2	8:00A	2	830	900	609	48.8	<0.1	8.2	0	346	40	9.50	68.6	8.83	39,430	42,750	930
		12-7	8:15A	0	740	650	589	37.6	<0.1	8.3	0	347	40	10.69	73.1	4.44	17,690	15,540	930
		12-9	8:00A	0	840	750	614	43.6	Trace	8.3	0	348	40	11.31	77.35	2.73	12,340	11,020	230
G	Bear R. West of Preston, Idaho	11-7	6:30A	5	135	355	994	36.8	<0.1	7.7	0	265	100	9.56	74.7	1.21	878	2,310	430
		11-10	6:45A	6	425	462	658	8.8	<0.1	8.2	0	318	8	9.14	73.2	1.70	3,887	4,230	93
		11-16	6:20A	0	200	354	665	8.0	Trace	8.2	0	320	7	12.09	82.7	1.64	1,765	3,120	93(c)
		11-18	6:15A	1	-	-	607	19.0	<0.1	8.2	0	333	15	10.58	74.3	1.47	-	-	230
		11-23	6:20A	1	300	600	620	13.6	Trace	8.2	0	348	15	10.79	75.8	1.43	2,308	4,616	930
		11-25	6:10A	0	600	310	580	17.8	Trace	8.2	0	343	10	10.20	69.8	1.24	4,000	2,068	75(c)
		11-30	6:30A	4	380	650	639	15.6	Trace	8.1	0	353	15	10.10	76.9	0.93	1,901	3,250	93
		12-2	6:45A	2	290	440	710	46.4	Trace	8.1	0	357	50	10.43	75.4	0.68	1,060	1,610	93
		12-7	6:30A	1	220	380	651	23.6	Trace	8.2	0	338	25	10.61	74.6	0.76	899	1,553	93
		12-9	6:35A	1	290	550	644	17.4	Trace	8.1	0	354	15	10.62	74.6	0.94	1,466	2,780	430
H	Worm Creek above Cub R. Canal	11-9	8:00A	4	2.2		484	26	<0.1	8.1	0	332	25	9.83	74.9	0.87	10.3	9,300	
		11-11	7:45A	4	1.8		472	26.4	Trace	8.1	0	330	35	8.37	63.7	1.00	9.69	15,000	
		11-14	7:55A	2	1.0		454	38.8	Trace	8.1	0	308	50	9.70	70.1	2.38	12.81	-	
		11-17	7:12A	0	2.5		502	59.6	Trace	8.3	0	360	75	10.08	68.9	2.49	33.5	43,000(c)	
		11-21	8:05A	4	4.0		498	118	<0.1	8.1	0	314	150	9.48	72.2	2.57	55.4	39,000	
		11-24	7:12A	2	3.2		498	107	Trace	8.1	0	322	180	10.43	75.4	4.51	77.7	9,300	

Table A-1 (Continued)

TABULATION OF STREAM SURVEY DATA

STATION No.	STATION Description	DATE	TIME	TEMP °C	RATE OF FLOW (cfs)	SOLIDS (ppm) Total	Susp.	Settleable m/l	pH	ALKALINITY ppm Phenol.	ALKALINITY ppm Total	TURB ppm	D. O ppm	D. O % Sat.	B. O. D. ppm	B. O. D. #/day	COLIFORMS (MPN/100ml)
H (Continued)		11-28	7:00A	3	4.4	551	164	0.1	8.1	0	320	200	9.91	73.5	2.33	55.2	43,000
	Worm Creek	12-1	7:15A	4	4.5	594	218	0.15	8.1	0	314	230	9.52	72.5	2.30	55.7	230
	above Cub	12-5	7:14A	0	4.0	579	187	0.2	8.1	0	323	180	10.95	74.9	1.81	39.0	15,000
	R. Canal	12-8	7:35A	0	3.2	566	192	Trace	8.0	0	340	230	10.94	74.8	1.87	32.2	4,300
I	Cub R.	11-9	9:40A	2	22.4	204	5.8	Trace	8.1	0	166	3	11.48	82.9	0.22	26.5	230
	Canal above	11-11	8:05A	4	21.0	211	4.2	Trace	8.1	0	167	4	9.54	72.7	0.59	66.6	430
	Franklin	11-14	8:21A	4	16.0	212	14.2	0	8.0	0	164	15	10.70	77.3	1.09	93.8	-
	Sugar Co.	11-17	8:00A	0	15	238	7.2	Trace	8.0	0	202	6	(b)	-	1.19	96.1	2,300(c)
		11-21	8:25A	0	15	197	3.4	0	8.0	0	171	2	9.56	65.4	0.96	77.4	230,000
		11-24	7:40A	0	15.0	218	4.0	Trace	8.1	0	186	3	11.21	76.7	0.51	41.2	2,300
		11-28	7:30A	4	16.0	224	5.6	Trace	8.1	0	190	5	10.05	76.5	0.36	31.0	2,300
		12-1	7:43A	4	12.5	249	11.6	0	8.0	0	194	15	9.78	74.5	0.81	54.4	430
		12-5	No water		0.5												
		12-8	No water		0.5												
J	Worm Creek	11-9	8:30A	3	14.7	258	4.0	Trace	8.1	0	197	6	9.97	74.0	2.38	188.1	4,300
	below Cub	11-11	7:55A	6	13.5	266	12.4	<0.1	8.0	0	191	6	8.11	65.0	2.54	184.5	23,000
	R. Canal	11-14	8:10A	3	9.5	346	19.4	Trace	8.0	0	245	30	9.51	70.5	5.05	258.0	-
	and above	11-17	7:35A	0	9.0	261	8.6	Trace	8.0	0	204	10	10.24	70.0	4.06	196.5	2,300(c)
	Sugar Co.	11-21	8:15A	10	10.6	205	5.2	0	8.0	0	176	5	8.72	77.0	1.07	61.0	930
		11-24	7:25A	0	10.6	244	9.6	Trace	8.1	0	197	7	10.31	70.5	1.20	68.4	21,000
		11-28	7:11A	4	11.5	251	14.6	Trace	8.1	0	196	15	9.58	73.0	1.82	112.6	4,300
		12-1	7:32A	6	8.5	328	55.0	Trace	8.0	0	226	70	9.24	74.0	2.00	91.5	9,300
		12-5	7:30A	0	7.0	533	138	0.1	8.0	0	310	150	10.76	73.6	3.83	144.2	2,300
		12-8	7:40A	0	6.0	514	134	0.1	8.0	0	322	160	10.01	68.5	4.17	134.6	230,000

Table A-1 (Continued)

TABULATION OF STREAM SURVEY DATA

STATION No.	STATION Description	DATE	TIME	TEMP °C	RATE OF FLOW (cfs)	SOLIDS (ppm) Total	SOLIDS (ppm) Susp.	SOLIDS (ppm) Settleable m/l	pH	ALKALINITY ppm Phenol.	ALKALINITY ppm Total	TURB ppm	D. O. ppm	D. O. % Sat.	B. O. D. ppm	B. O. D. */day	COLIFORMS (MPN/100ml)
K	Worm Creek	11-9	9:20A	9	16.5	2220	1100	5	7.8	0	887	1200	2.04	0.34	617	54,800	4,300,000
	above State	11-11	8:40A	10	16.5	2410	1520	11	7.7	0	1040	1300	0.08	0.70	527	46,800	430,000
	line	11-14	9:15A	6	14.5	2190	1240	5.5	7.6	0	1070	1400	1.72	13.8	496	38,700	-
		11-17	8:40A	1	19	1190	508	1.4	7.8	0	576	400	3.59	25.2	297	30,400	930,000(c)
		11-21	9:00A	5	24.5	1030	83.0	1.3	7.9	0	489	450	3.98	31.1	186	24,500	150,000
		11-24	8:20A	4	23.0	1000	359	0.7	7.8	0	532	380	3.48	26.5	191	23,600	4,300,000
		11-28	8:12A	5	27.0	914	334	1.0	7.8	0	468	400	3.16	24.7	159	23,100	430,000
		12-1	8:14A	6	25.0	609	152	0.3	7.9	0	356	130	3.46	27.7	45.5	6,120	750
		12-5	8:08A	0	17	643	88.5	<0.1	7.8	0	401	110	5.84	39.9	66.3	6,060	43,000
		12-8	8:14A	0	16.5	585	47.5	Trace	7.9	0	392	70	6.47	44.3	56.3	4,990	230,000
L	Cub R.	11-9	9:05A	3	4.9	304	7.4	Trace	8.2	0	226	8	11.06	82.0	0.65	17.14	930
	above State	11-11	8:25A	4	4.6	313	3.8	Trace	8.2	0	231	3	8.78	66.9	0.74	18.33	230
	line	11-14	9:30A	0	4.6	325	10.6	Trace	8.1	0	239	7	11.14	76.2	1.32	32.65	-
		11-21	8:45A	2	4.0	290	7.2	Trace	8.0	0	221	10	9.85	71.2	0.95	35.78	43,000
		11-24	8:02A	1	10.6	319	3.8	0	8.0	0	244	3	10.27	72.2	0.68	38.77	230
		11-28	7:58A	4	17.4	306	13.0	Trace	8.1	0	228	10	9.65	73.5	0.92	86.1	930
		12-1	8:00A	4	18.3	317	17.0	Trace	8.0	0	238	10	9.40	71.6	0.88	86.6	430
		12-5	7:50A	0	15.4	346	14.0	Trace	8.0	0	250	10	11.06	75.6	0.50	41.4	230
		12-8	8:00A	0	6.4	319	6.2	0	8.0	0	255	7	10.77	73.7	0.55	18.95	230
M	Cub R.	11-9	9:35A	5	24	808	161	0.2	7.7	0	400	210	0.95	7.42	228	29,500	230,000
	above	11-11	9:00A	7	24	919	97	0.15	7.6	0	455	120	0.0	0.00	355	45,900	230,000
	Amalgamated	11-14	9:50A	2	22	966	116	Trace	7.7	0	476	240	0.50	3.61	380	45,000	No value
	Sugar Co.	11-21	9:16A	3	35	720	186	0.4	7.8	0	385	200	4.40	32.64	122	23,000	430,000
		11-24	8:40A	2	37	685	110	0.1	8.0	0	366	150	4.57	33.0	132	26,300	2,300,000

Table A-1 (Continued)

TABULATION OF STREAM SURVEY DATA

STATION No.	STATION Description	DATE	TIME	TEMP °C	RATE OF FLOW (cfs)	SOLIDS (ppm) Total	SOLIDS (ppm) Susp.	SOLIDS (ppm) Settleable m/l.	pH	ALKALINITY ppm Phenol.	ALKALINITY ppm Total	TURB ppm	D. O. ppm	D. O. % Sat.	B. O. D. ppm	B. O. D. #/day	COLIFORMS (MPN/100ml)
M (Continued)		11-25	8:30A	4	47	728	232	0.5	7.8	0	401	250	3.20	24.4	96.0	24,300	93,000
	Cub R.	12-1	8:36A	5	46	486	49.0	<0.1	7.8	0	310	65	3.56	27.8	33.2	8,220	230
	above	12-5	8:26A	0	35	597	32.4	Trace	7.9	0	338	45	7.20	49.2	94.0	17,700	2,300
	Amalgamated Sugar Co.	12-8	8:36A	0	26	449	14.4	Trace	8.0	0	330	25	7.99	54.7	19.6	27,400	23,000
N	Cub R.	11-10	9:50A	8	57	914	24	<0.1	7.5	0	344	85	1.46	12.3	420	128,800	230,000
	below	11-11	9:30A	10	62	1000	26	0.1	7.2	0	358	70	1.33	11.7	500	167,000	230,000
	Amalgamated	11-14	10:15A	5	62	1250	41	0.2	7.2	0	395	100	1.54	12.0	670	223,400	
	Sugar Co.	11-17	9:30A	2	40	1100	45	Trace	7.8	0	394	130	2.87	20.7	572	123,200	230,000(e)
		11-21	9:33A	6	60	782	19	Trace	7.7	0	343	100	3.08	24.7	240	77,400	230,000
		11-24	9:05A	4	62	799	24.0	Trace	7.8	0	358	110	7.24	55.2	218	72,800	9,300,000
		11-28	8:45A	6	78	786	21.0	<0.1	7.6	0	364	60	2.64	21.2	262	110,000	93,000
		12-1	8:55A	6	71	475	10.0	Trace	7.6	0	309	25	3.65	29.2	65.3	24,900	430
		12-5	8:45A	0	55	598	10.4	Trace	7.6	0	321	20	5.05	34.5	116	34,300	43,000
		12-8	9:00A	0	15	460	21.6	Trace	7.7	0	327	30	9.41	64.4	30.4	24,500	2,300

(a) Sampler and bottles froze; could not get sampler open, etc.
(b) Water not deep enough for D.O. sampler
(c) Samples frozen
(d) Flow at sampling time
(e) Mean daily flow

APPENDIX B

TABULATION OF COLIFORM DATA

TABLE B-1

BEAR RIVER SYSTEM

MPN COLIFORMS PER 100 ML

Station	Date	Range	Median	No.	By
A	8/25 - 9/30 '52	230 - 2100	730	5	Utah
	5/31 '51	13,000	13,000	1	Utah
	11/7 - 12/9 '55	1,500 - 93,000	18,000	10	PHS
H	3/2 - 3/6 '53	73 - 46,000	2,400	5	Idaho
	6/8 - 6/12 '53	11,000 - 24,000	11,000	5	Idaho
	9/14 - 9/18 '53	110,000 - >240,000	>240,000	5	Idaho
	11/7 - 12/9 '55	230 - 43,000	15,000	10	PHS
I	3/2 - 3/6 '53	200 - 11,000	5600	2	Idaho
	6/8 - 6/12 '53	430 - 2400	430	5	Idaho
	9/14 - 9/18 '53	1,500 - 24,000	4,300	5	Idaho
	11/7 - 12/2 '55	230 - 230,000	2,300	7	PHS
K	3/2 - 3/6 '53	360 - 46,000	7,500	5	Idaho
	3/2 - 3/6 '53	24,000 - 240,000	46,000	5	Utah
	6/8 - 6/12 '53	9,300 - 110,000	24,000	5	Idaho
	6/8 - 6/12 '53	7,500 - 46,000	21,000	5	Utah
	9/14 - 9/18 '53	2,100 - 110,000	24,000	5	Idaho
	9/14 - 9/18 '53	4,300 - 46,000	9,300	5	Utah
	11/7 - 12/9 '55	750 - 4,300,000	430,000	9	PHS
L	3/2 - 3/6 '53	>23 - 91	36	5	Idaho
	6/8 - 6/12 '53	160 - 2,400	750	5	Idaho
	9/14 - 9/18 '53	15,000 - 240,000	24,000	5	Idaho
	11/7 - 12/9 '55	230 - 43,000	330	8	PHS
M	8/25 - 8/29 '52	230 - 11,000	430	5	Utah
	3/2 - 3/6 '53	460 - 11,000	4,600	5	Utah
	6/8 - 6/12 '53	2,300 - 9,300	4,300	5	Utah
	9/14 - 9/18 '53	930 - 4,300	1,500	5	Utah
	5/31 '51	230	230	1	Utah
	11/7 - 12/9 '55	930 - 2,300,000	163,000	8	PHS

APPENDIX C

TABULATION OF DISCHARGE RECORDS

Table C-1

Stream Discharge Data For Regular USGS Stations on The Bear River

Bear River Near Collinston (2000' Downstream From Cutler Dam and 5⅛ Miles N. of Collinston

Water Year	Mean Monthly Discharge (Second Feet)												Min.	Max.	Mean	Min. & Max. For Period of Record
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.				
1953-1954*	573	957	958	1025	1200	1367	1535	331	217	45.5	34.7	267			1157	
1952-1953	1351	1547	1846	1970	1921	1799	2055	1542	1780	71.2	167	177	22	3510	1347	('89-'53)
1952	1763	1836	2023	2247	2161	2398	5195	4436	1791	811	880	1070	31	6670	2215	Max. 11,600 June 7-9 '09
1951	2303	2364	2620	2511	3015	2878	3601	3685	1527	788	1314	1315	41	5220	2323	Min. Nearly 0 Aug. 5 '20 (Regulated)
1950	1548	1387	1472	2068	2348	2244	3630	4393	3436	1869	1353	1590	192	5700	2275	
1949	1308	1438	1572	1651	1825	2437	2673	2528	882	129	294	602	23	3830	1442	
1948	1325	1593	1610	1285	1624	1440	2695	3476	1758	298	464	646	20	3760	1516	
1947	1228	1670	1760	1459	1692	1801	1946	2106	1459	238	831	1019	24	3460	1431	
1946	780	1402	1399	1409	1189	2462	4351	2593	1085	133	572	709	24	6530	1505	
1945	448	892	763	805	1657	1502	1548	2238	2733	93.1	366	682	22	5030	1136	
1944	925	1135	1056	915	1004	1409	1729	1921	1309	32.2	25.2	30.2	19	2990	956	
1943	594	930	1086	1287	1436	1837	3464	2053	2001	148	127	230	18	4470	1259	
1942	780	852	1003	943	1104	1625	2671	2160	343	35	21	115	17	3110	970	
1941	608	808	850	773	1322	1371	1480	867	113	22.2	70.4	155	15	2510	699	
1940	732	668	789	879	1145	1390	1230	257	34.8	20.3	19.6	258	18	2130	617	
1939	872	1440	1340	971	1110	2090	1770	845	49.5	20.9	19.7	428	18	3680	911	
1938	839	870	1146	956	1290	1819	2662	2804	553	332	17.8	96.3	16	4800	1115	
1937	732	1085	996	907	1069	2162	2258	2580	678	104	17.6	54.0	14	4670	1054	
1936	345	666	630	830	1155	1303	3488	3806	1331	21.0	20.8	102	18	7240	1139	
1935	308	719	701	589	915	1106	1215	1268	630	21.3	20.0	18.9	18	2920	623	
1934	327	737	981	929	876	792	485	27.3	23.6	22.2	19.5	111	17	1640	442	
1933	498	747	860	848	928	1450	1930	2230	785	33.5	31.8	32.5	28	3410	863	

* From unpublished USGS records

Table C-1 Con't.

Stream Discharge Data For Regular USGS Stations on The Bear River

Bear River Near Corrine (2.0 Miles NE of Corrine and 2.6 Miles Downstream From Malad R.)

Water Year	Mean Monthly Discharge (Second Feet) Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Min.	Max.	Mean	Min. & Max. For Period of Record
1953-1954*	711	1128	1124	1191	1305	1508	1750	505	355	123	113	345			842	
1952-1953	1478	1768	1975	2242	2035	1898	2125	1706	1990	178	258	254	90	3350	1487	('49-'53)
1952	1936	2083	2164	2423	2407	2604	5697	4869	2033	945	1012	1203	183	7180	2445	Max. 7200 May 3, 1952
1951	2388	2524	2708	2669	3507	3062	3809	3955	1673	915	1455	1439	203	6850	2502	Min. 90 Aug. 18, 1953
1950	1713	1618	1612	2174	2595	2620	3840	4698	3705	2088	1427	1714	5820	601	2480	

Bear R. Near Preston Idaho (600' downstream from head gates of W. Cache Canal & 5 Miles N. of Preston)

1953-1954*	319	409	467	420	456	611	680	495	521	782	754	543			539	('44-'53)
1952-1953	962	836	1224	1123	1105	1026	1006	753	752	847	678	548	79	1830	905	Min. 0.6 June 14, '49
1952	1197	1168	1385	1540	1389	1377	1956	1768	1011	973	1095	1110	287	2940	1331	
1951	1663	1574	1717	1667	1662	1666	1805	1366	1064	1191	1340	1374	218	2230	1507	
1950	832	732	817	1045	1117	931	1891	1785	1903	1594	1489	1580	256	3410	1309	
1949	930	874	1070	1160	1030	785	1100	723	497	664	900	737	120	1720	872	
1948	960	994	966	731	661	594	1146	1195	756	860	883	905	20	2260	888	
1947	685	861	887	921	609	770	730	761	687	950	1161	1044	14	1810	841	
1946	534	532	594	485	510	774	1873	1020	590	691	931	735	130	2640	773	
1945	273	415	448	391	523	615	834	939	1031	532	601	436	14	2250	586	
1944	----	----	----	474	469	569	796	671	426	659	740	478	----	----	----	

* from unpublished records of the USGS

APPENDIX D

TABULATION OF WEATHER DATA

TABLE D-1

WEATHER DATA

Information obtained from U. S. Weather Bureau
Weather Station located at Utah State Agriculture College
Logan, Utah

Date	Weather Temperatures °F		Precipitation (inches)
	Maximum	Minimum	
November 7	46	26	trace
8	49	26	
9	52	27	
10	57	33	
11	40	30	0.14
12	28	22	
13	38	15	
14	36	19	1.09
15	10	-1	0.31
16	8	-16	
17	31	-10	0.04
18	40	7	0.07
19	50	30	
20	55	37	
21	49	32	
22	34	25	0.36
23	38	19	
24	42	20	
25	41	22	
26	48	29	
27	48	41	0.10
28	53	37	
29	45	32	
30	41	34	
December 1	40	33	0.17
2	33	26	0.90
3	28	24	Trace
4	24	16	0.04
5	30	6	
6	37	6	0.03
7	29	22	0.09
8	24	14	
9	32	14	Trace

APPENDIX E

INDUSTRIAL WASTE SURVEY REPORTS

REPORT OF SURVEY OF UTAH-IDAHO SUGAR COMPANY, GARLAND, UTAH

November 7-11, 1955

Collection of Information

The information reported here is the result of observation of the plant operation by C. K. Sudweeks, Utah State Dept. of Health and A. E. Becher, PHS, and conferences with the follcwing plant officials:

Mr. F. T. Scalley, District Manager

Mr. J. E. Arnold, Plant Superintendent

Mr. A. G. Campbell, Plant Chemist

Flow data collection and sampling were carried out by plant employees under supervision of PHS and Utah Health Dept. personnel. Chemical analyses on samples collected at the plant were run in the PHS mobile lab. at Logan. Plant officials were extremely cooperative in helping with the sampling, installing flow measuring devices, and in supplying information about plant operation.

Plant Operation

The Utah-Idaho Sugar Co. plant at Garland, Utah, employs the Steffens process for the production of approximately 320 tons per day of bagged white sugar in three grades. The plant handles about 2000 T per day, or 38 to 40 (50T) carloads of beets and about 140 T per day of foreign molasses. Approximately 45 T of concentrated Steffens Filtrate are produced daily for shipment to California for the production of Monosodium Glutamate. Discard molasses amount to about 40 T per day or about 2% of molasses on beets. These molasses are used principally for animal feed. The total water consumption, exclusive of potable and

boiler feed water, is from 5000 to 6000 GPM. Potable water is used only in drinking fountains and the laboratory, and boiler feed water is made up from condensate from evaporator steam chests. This plant has a 14 cell bottom-dump battery comprised of 330 cubic foot or 6 ton capacity cells. Production of sugar normally lasts for about 60 days and is on a continuous 24-hour achedule. About 250 persons are employed on three shifts.

Beet cutting for the 1955 campaign was begun at 10:00 AM on October 8 and finished at 6:00 AM on December 5. The last sugar was out of the plant at 12:00 noon on December 8. During the two month period a total of 113,889 tons of beets were processed. Beets processed during the survey were:

November 7	2,062 Tons
November 9	2,048 Tons
November 10	2,131 Tons
November 11	2,158 Tons

Waste Disposal

All plant wastes are discharged to the Malad River. Wastes must be discharged through one of three outfalls, the main sewer, lime pond outfall, and silage drain and no by-pass sewers are known to exist.

The main sewer carries flume water and all other wastes not mentioned in the other outfall discussions. No Steffen waste is discharged but a small amount of the mud from the Peterson filter in the Glutamate plant is discharged to the main sewer. Lime can be discharged to the main sewer in several ways. Although floor drains are in almost all cases returned to the process, a sump in the Steffens house is valved so that it

may be discharged to the main sewer. Normally this sump is pumped back into the process. It is possible to dump lime from the Raymond mills into the main sewer, via a manhole, when they become clogged. This practice is not common, and when it is necessary discharge amounts to a wheelbarrow load or so. The Oliver vacuum filters are drained, when necessary, to the main sewer. Filter cloth wash water is discharged to this sewer.

At the conclusion of the campaign each year the pans are given an acid cleaning and this is also washed to the main sewer. No treatment is provided for this outfall except for vibrating screens which remove leaves and other debris for grinding and disposal in the silage pit.

Waste lime is discharged to a lagoon. During the course of this survey, particularly on 7 and 11 November, the waste was confined to a narrow channel in the lime deposit in the bottom of the lagoon and there was very little detention time.

The silage drain carries drainage from the silage pit, drainage from the cinder pond, and some sewage from the City of Garland. Silage is pumped to the pit in the water used to wash the battery. This water is removed in one of two dewatering screens and discharged to the main sewer. On 7 and 9 November the south screen was in use. Large quantities of pulp in the outfall and the appearance of a depression near the screen caused suspicion of a failure in the silage pit bottom. On 10 November the north screen was used and on 11 November both were in use. In the event of a pumping failure silage can be discharged by gravity to the north end of the pit. It was observed in the course of

this survey that most of the screens covering the small slots in the pit bottom were removed or broken. Cinders from the boiler house are mixed with sufficient water to form a slurry and pumped to the cinder pond. Effluent from this pond overflows to the silage drain. Garland sewage from an estimated population of less than 1200 discharges to a channel below the silage pit. No method of separately gauging this waste was available while the plant was in operation. Data obtained just prior to the start of plant operation provided an estimate of its volume, however.

Evaporator condenser water (River water and pan condensate) is not discharged directly to sewers but is used on the Oliver filters, gas washer, lime kiln and for similar purposes. Condensate from Evaporator steam chests is not discharged to sewers. It is used principally for boiler feed water and also for general hot water supply, battery supply, and centrifugal wash with a small amount used in the concentrated Steffens filtrate plant.

Chemical Data

Samples for chemical analysis were collected at hourly intervals and composited at each of the following outfalls:

Main sewer - carrying flume, wash, and pulp screen water

Silage drain - carrying silage pit drainage, cinder pond drainage and Garland sewage

Lime pond drainage (pond outlet)

Composites were made to cover an eight-hour period, and were collected at 5:00 AM through 12:00 noon. Due to the almost constant flow in all three outfalls, uniform samples of 400 ml. were collected at each outfall.

This provided composites of slightly less than one gallon as requested by the chemist. Determinations made on each composits included:

pH

B.O.D. (5 day)

Alkalinity

Total solids

Total suspended solids

Settleable solids

Samples were collected on 7, 9, 10, and 11 November. Analytical results are shown in Table E-1.

Flow Data

Data were collected at hourly intervals by means of Parshall flumes at each of the three outfalls. The main sewer was provided with a 24-inch Parshall flume with an 18-inch throat depth. This proved slightly inadequate during surges which occurred at intervals throughout the day due to beet pile-ups in the beet flume. These surges combined with turbulence in the channel preceding the flume made accurate measurement difficult. The silage drain was provided with an identical Parshall flume which was quite adequate for the range of flows encountered there. The lime drainage was measured at the inlet to the lime pond by means of a 9-inch Parshall flume. This flume functioned satisfactorily, although it was necessary to remove lime deposits before making observations. It was not possible to gauge flows at the lime pond outlet, but both inflow and outflow appear to be occurring at approximately constant rate. Flow data are summarized in Table E-2.

Table E-1

TABULATION OF CHEMICAL DATA

UTAH-IDAHO SUGAR COMPANY

STATION No.	STATION Description	DATE	MEAN TEMP °C	MEAN DISCHARGE (cfs)	SOLIDS (ppm) Total	SOLIDS (ppm) Susp.	SOLIDS (ppm) Settleable m/l.	pH	ALKALINITY (ppm) Phenol	ALKALINITY (ppm) Total	TURB.	B. O. D. (ppm)	B. O. D. #/day	REMARKS
UA	Main sewer outfall	11-7	28	11.9	3,200	2,070	8.5	9.0	37.0	304	1,000	397	25,400	
		11-9	25	11.9	4,090	2,190	44	11.9	780	1,260	-	488	31,200	
		11-10	22	11.9	3,140	1,820	4.0	8.7	25.2	407	-	129	8,250	
		11-11	25	11.9	3,390	1,880	7.5	8.7	16.2	396	-	365	23,400	
		MEAN	25	11.9	3,455	1,990	16	9.6	215	592	-	345	22,060	
UB	Silage drain - including Garland sewage, cinder pond discharge	11-7	25	2.55	5,690	1,320	18.5	6.6	0	755	350	2,350	32,250	S.screen in use
		11-9	27	2.61	5,060	1,180	14	6.8	0	730	-	228	3,200	Much pulp visible in outfall.
		11-10	35	3.69	4,760	1,470	19	7.1	0	623	-	1,560	30,950	N. Screen in use
		11-11	27	2.01	7,230	4,630	112	6.9	0	368	-	3,320	35,920	Both Screens used
		MEAN	29	2.07	5,685	2,150	40.9	6.9	0	619	-	1,865	25,360	
UC	Lime Pond outfall	11-7	7	0.22	148,000	146,000	240	11.4	10,300	116,000	90,000	5,660	6,700	Pond short-circuiting badly
		11-9	4	0.22	3,220	514	0.5	10.3	83.4	510		380	450	-
		11-10	5	0.22	1,210	229	0.3	10.6	94.2	303		340	403	-
		11-11	9	0.23	223,000	219,000	560	11.5	8,000	172,000		10,300	12,700	-
		MEAN	6	0.22	68,860	91,440	200	11.0	4,619	72,200	-	4,170	5,063	Pond short-circuiting badly

Table E-2

Utah-Idaho Sugar Co.

Summary of Flow and Temperature Data

Main Sewer (Station UA). (Flows and temperatures at time of sampling are shown. Due to surges caused by pileups in the beet flume, considerable momentary fluctuations were observed. As previously mentioned, readings were difficult to obtain. Samplers were instructed to avoid these surges as much as possible in sampling. On 7 Nov., the first sampling day, observations were made at two-minute intervals for one hour. These showed a mean flow of 11.9 cfs and a range of from 9.3 to 15.0 cfs.)

	Flow (CFS)		Temperature (°C)	
Date	(Range)	(Mean)	(Range)	(Mean)
7 Nov.	8.0-12.0	9.8	22°-31°	28°
9 Nov.	9.3-13.5	11.9	23°-29°	25°
10 Nov.	8.0-12.0	10.5	20°-26°	22°
11 Nov.	9.3-12.0	11.2	22°-34°	25°
Silage Drain (Station UB) - Including Garland Sewage				
7 Nov.	2.48-2.65	2.55	22°-30°	25°
9 Nov.	2.09-2.90	2.61	26°-31°	27°
10 Nov.	2.90-4.72	3.69	30°-40°	35°
11 Nov.	1.93-2.40	2.01	26°-29°	27°
(Before Plant Began Operation - Garland Sewage Only - 12 Hourly Observations On Each Day From 7:00 AM to 6:00 PM)				
4 Oct.	0.61-0.82	0.67	------	---
6 Oct.	0.61-0.66	0.62	------	---
Lime Pond (Station UC)				
7 Nov.	.22-.24	.22	6°-9°	7°
9 Nov.	.20-.24	.22	2°-4°	4°
10 Nov.	.20-.28	.22	4°-6°	5°
11 Nov.	.20-.26	.23	7°-10°	9°

Observation of Outfalls and Samples

The waste at the main sewer outfall contained recognizable bits of leaves. On several occasions slugs of material resembling lime were observed for 5 to 10 minute periods in the main sewer. The silage drain contained large amounts of pulp throughout the survey. Bits of cinder and a black color were characteristic of this waste also. The lime pond waste was loaded with lime particles on 7 and 11 November. It did not appear materially different than the waste entering the pond.

Discussion

Waste volume discharged via the main sewer ranged from 3563 to 3755 gallons with a mean of 3664 gallons per Ton of beets processed. This is somewhat higher than the representative value of 2840 gallons per ton, reported in the Public Health Service Industrial Waste Guide To The Beet Sugar Industry,(2) for flume water and pulp screen water. The additional volume may be attributable to the additional dilute wastes carried by the sewer. The concentration of 5-day B.O.D. is also higher than is indicated for flume water and pulp screen water only. A representative value(2) might be 275 ppm while this outfall during sampling ranged from 129 to 488 ppm with a mean of 345 ppm. The B.O.D. load in pounds per ton daily ranged from 3.9 to 15.2 with a mean of 10.6. This is considerably higher than the representative value in The Industrial Waste Guide(2) of 6.5 for the two principal wastes. The additional B.O.D. could result from either the other wastes discharged to the sewer or from a larger amount of frozen beets in the flume water itself. The suspended solids concentration ranging from 1820 to 2190 ppm with a mean of 1990 ppm is well within a representative(2) range for these wastes.

Flow from the pulp silo drain including drainage from the cinder pond but corrected for the Garland sewage discharged to the outfall ranged from 407 to 920 gallons per ton of beets processed with a mean of 636 gallons. This is considerably higher than the highest figure cited in the Guide[2] of 270 gallons for silo drainage only. It is doubtful that the additional flow could be accounted for by the cinder pond drainage alone. The high flow is considered to result from failure of the pulp screen to efficiently reduce the water content of pulp entering the silo. The 5-day B.O.D., exclusive of Garland sewage discharged, on November 9 was apparently only 1.4 pounds per ton of beets processed. On the other three days it ranged from 14.4 to 16.6 pounds per ton. The mean for the four days was 12.0 pounds per ton. These values compare reasonably well with the 12.3 pounds per ton figure given by The Guide[2] particularly in light of the great variability in strength of this waste. The suspended solids concentration, however, was extremely high in spite of high flows, ranging from 1180 to 4030 ppm with a mean of 2150 ppm. The representative value cited [2] is 270 ppm for a flow of 210 gallons per ton of beets processed. A solids loss (dry basis) of 24 times the representative case is therefore indicated for this outfall. Excessive amounts of pulp were visable in the waste throughout the survey but particularly when the south pulp screen was in use. It is believed that the high solids (pulp) loss results from failure of the individual screens covering joints in the silage pit bottom and/or a major failure in the pit bottom near the south pulp screen.

The lime cake pond was channeling and obviously not operating satisfactorily on November 7 and 11. This was reflected in extremely high

solids, B.O.D., pH and alkalinity. On November 9 and 10 when the pond appeared to be operating somewhat better, mean flow was 68 gallons per ton of beets, mean B.O.D. concentration 360 ppm, mean B.O.D. load 0.2 pounds per ton of beets and mean suspended solids concentration 372 ppm, all of which compare favorably with the representative values(2). The B.O.D. load on November 11 had been 30 times as high as November 9 and 10. The poor performance on the 7th and 11th was the result of failure to keep the pond overflow at a level above lime deposition in the pond.

The mean total waste discharged from the plant was 4369 gallons and 25 pounds of 5-day B.O.D. per ton of beets processed during the period of the survey. This would indicate for the two months of the 1955 campaign with average beet processing at approximately 1840 tons per day a mean daily total discharge of 46,000 pounds of B.O.D. or a population equivalent of approximately 271,000. A summary of the individual waste loads and volumes is shown in Table E-3.

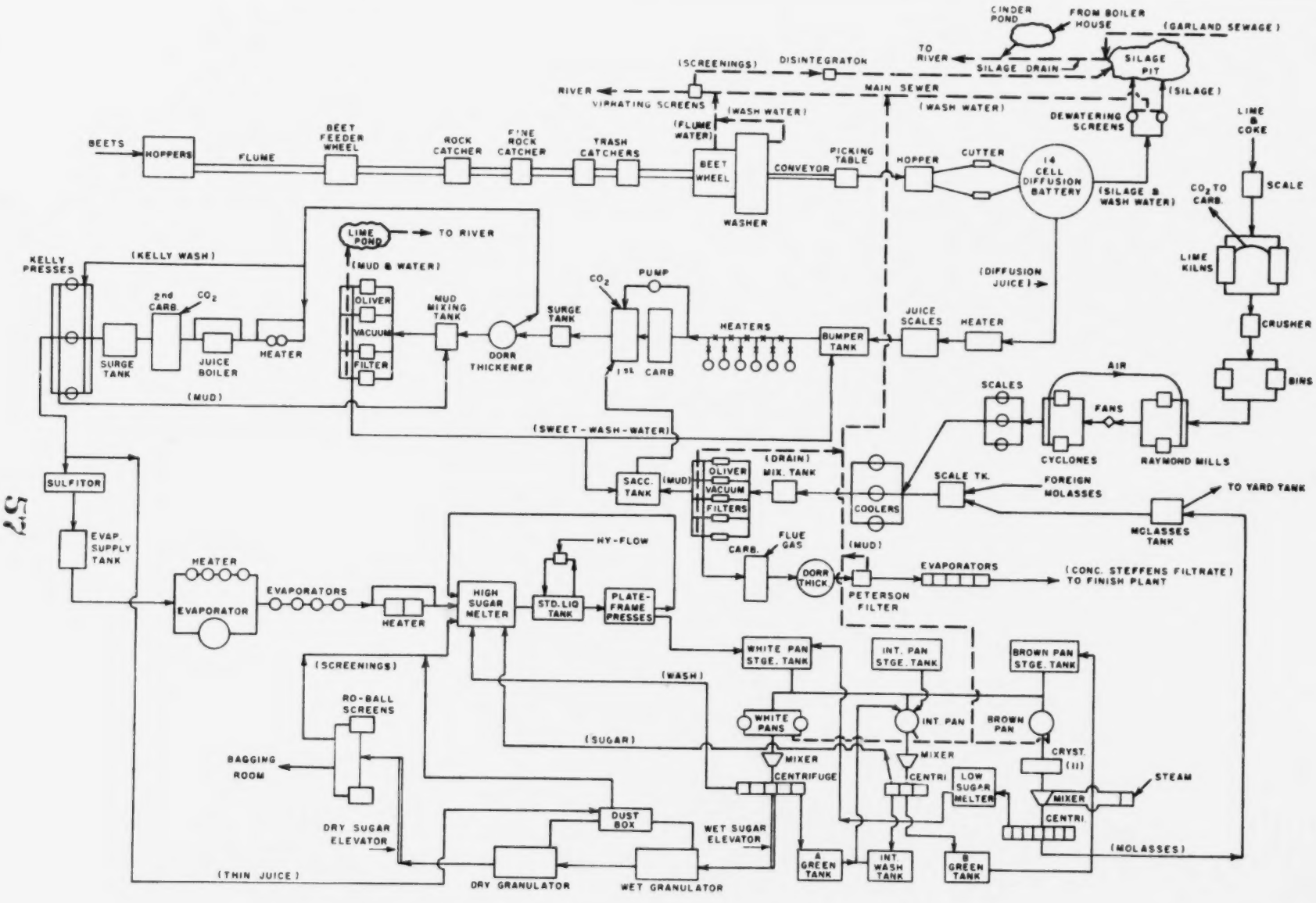
Table E-3

Waste Loads and Volumes - Utah-Idaho Sugar Co.

Date	Tons Beets	Flow CFS	Flow MGD	B.O.D. #/Day	B.O.D. #/Ton	Flow Gal/Ton
UA - Main Sewer - Flume water + Pulp Screen Water + Misc. Wastes						
Nov. 7	2062	11.9	7.69	25,400	12.3	3729
Nov. 9	2048	11.9	7.69	31,200	15.2	3755
Nov.10	2131	11.9	7.69	8,250	3.9	3609
Nov.11	2158	11.9	7.69	23,400	10.8	3563
Mean	2100	11.9	7.69	22,060	10.6	3664
UB - Silage Drain - Drainage from Pulp Silo + Cinder Pond - Garland Sewage * (Pop.1200)						
Nov. 7	2062	1.90	1.23	32,010	15.5	597
Nov. 9	2048	1.96	1.27	2,960	1.4	620
Nov.10	2131	3.04	1.96	30,710	14.4	920
Nov.11	2158	1.36	0.879	35,780	16.6	407
Mean	2100	2.07	1.34	25,360	12.0	636
UC - Lime Pond Drain						
Nov. 7	2062	0.22	0.142	6,700	3.2	69
Nov. 9	2048	0.22	0.142	450	0.2	69
Nov.10	2131	0.22	0.142	403	0.2	67
Nov.11	2158	0.23	0.149	12,700	5.9	69
Mean	2100	0.22	0.144	5,063	2.4	69
Mean Total	2100	14.2	9.17	52,482	25.0	4369

*Note: Flow corrected by 0.65 cfs as measured 4 & 6 Oct.

B. O. D. load by 240 #/day or .17#/day/capita



FLOW DIAGRAM—UTAH-IDAHO SUGAR CO.

FIGURE E 1

REPORT OF SURVEY OF FRANKLIN COUNTY SUGAR COMPANY, WHITNEY, IDAHO

November 14 - 18

Collection of Information

The information reported here is the result of observation of plant operation by A. E. Becher, PHS, and conferences with Mr. Thomas Heath, plant manager and Mr. Olson, plant superintendent. Mr. Alec Alexander of the Idaho State Department of Health was present at the initial tour of the plant. Chemical analyses were run in the PHS mobile lab. at Logan. Samples were collected and flow measurements were obtained by plant personnel by means of a weir installed by the company.

Plant Operation

The Franklin County Sugar Co. plant at Whitney, Idaho is a straight house producing about 190 tons per day of bagged white sugar. The plant normally handles about 1450 tons per day of beets. About 4.1% of molasses on beets are produced for animal feed. Total water consumption is approximately 4000 GPM under normal conditions. This water is obtained from the Cub River canal which is considered by plant officials to be an unusually good water supply. This plant has a 14 cell side-dump battery of 3.5 T capacity. Production of sugar lasts for from 40 to 50 days and is on a continuous 24-hour schedule. The plant employs 169 people on three shifts.

Refinery operation for the 1955 campaign was started October 12. Beet slicing stopped November 28 at 6:30 PM and the remainder of the refinery was shut down by 8:00 AM November 29. The complete cleanup including the sugar bagging operation was finished on December 3.

Production varied from a minimum of 993 tons to a maximum of 1466 tons of beets sliced per day. The minimum day was November 13 and resulted from an equipment breakdown. The maximum day was October 16. Average production was 1331 tons of beets sliced per day. Production in terms of beets sliced for the period of the survey was:

November 14	1215 tons
November 16	1134 tons
November 17	1271 tons
November 18	1230 tons

Waste Disposal

Plant wastes are all discharged to Worm Creek. All wastes except pulp silo drainage are discharged to the main plant sewer. The only other waste known to be discharged separately to the creek is water from washing railroad cars.

The pulp silo drain carries only drainage from the silo. Pulp is carried from the battery in the battery wash water and dewatered by two screens in the silage pit. Water removed is discharged to the main sewer.

In addition to water from the silage screens, the main sewer regularly carries flume water, beet washing water, sanitary sewage, lime waste, and discharge from those floor drains not returned to the house. Cinders are pumped to a pond in a slurry and the overflow from the pond discharged to the main sewer channel just above Worm Creek. The pans may be boiled out and drained to the plant sewer. This is done about three times per campaign according to employees working in the area.

No particular attempts to limit or treat wastes discharged to the main sewer were apparent.

Pan condenser water is not discharged directly to the sewer. Part of it is reused in the refinery for miscellaneous purposes and the remainder used for beet fluming.

Chemical Data

Samples for chemical analysis were collected at hourly intervals and composited at each of the following points:

Worm Creek just below confluence of silage drain, main sewer and cinder pond outlet (samples 14 Nov. only)

Silage drain at manhole above outfall (sampled Nov. 16, 17, 18)

Main sewer including cinder pond drainage (sampled Nov. 16, 17, 18)

Composites were made to cover an eight hour period and were collected at 5:00 AM through 12:00 noon. Due to almost constant flow in all outfalls, uniform samples of 400 ml were collected for compositing. Fluctuations in main sewer outfall flow are the result of temporary damming of the flume by beets and do not reflect variations in water use or in the nature of the waste. Determinations made on each composite include:

pH

5-day B.O.D.

Alkalinity

Total Solids

Total Suspended Solids

Settleable Solids

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Analytical results are summarized in Table E-4.

Table E-4

TABULATION OF CHEMICAL DATA

FRANKLIN COUNTY SUGAR COMPANY

STATION No.	STATION Description	DATE	MEAN TEMP. °C	MEAN DISCHARGE (cfs)	SOLIDS (ppm) Total	SOLIDS (ppm) Susp.	SOLIDS (ppm) Settleable m/l.	pH	ALKALINITY (ppm) Phenol	ALKALINITY (ppm) Total	B. O. D. (ppm)	B. O. D. #/day	REMARKS
FA	Worm Creek below outfalls	11-14	15	-	3,880	2,890	8.5	8.3	0	1,410	808	-	
FB	Main sewer	11-16	14	8.8	3,990	3,460	13	9.8	184	1,460	342	16,231	Recognizable bits of pulp
		11-17	15	8.2	6,850	1,640	10	6.8	0	1,820	1,490	65,894	
		11-18	15	9.0	6,760	5,520	38	10.2	305	3,570	496	24,075	
		MEAN	15	8.7	5,867	3,540	20	8.9	163	2,283	776	35,400	
FC	Pulp silo drain	11-16	30	0.51	7,390	448	16	4.1	372*	3,020**	12,100	33,006	
		11-17	31	0.51	6,230	1,150	12	4.3	0 *	822**	5,580	15,348	
		11-18	32	0.51	6,790	240	14	4.1	369*	2,940**	8,260	22,719	
		MEAN	31	0.51	6,803	613	14	4.2	247	2,261	8,647	23,691	

* Mineral acidity ** Total acidity

Flow Data

Data were collected at hourly intervals at the main sewer outfall by means of a 48-inch rectangular weir equipped with a staff gauge. The weir installation was somewhat crude, and an adequate stilling basin was not provided. The errors due to velocity of approach and high readings due to turbulence at the gauge were considered to balance each other. The silage pit drain outfall is submerged and the only manhole available for sampling would not permit installation of a flow measuring device. Measurement was made on 19 November by means of a Price current meter and measurement of liquid depth in the effluent pipe. The procedure was repeated three times between 3:00 and 4:30 PM with identical results. The value thus obtained was applied for all days of the survey. Flow data are summarized in Table E-5.

Weather Conditions during the Survey

The weather was unusually severe during the period of the survey. Over twelve inches of snow fell during the first day of the survey, and temperatures as low as 22°F below zero were reached.

Plant officials maintained during the survey that no difficulty was observed due to restricted water supply caused by freezing. They did state that considerable difficulty was encountered due to frozen beets. Mr. Olson estimated production to be down to 1300 T of beets daily from a normal 1450 T, at the beginning of the survey.

Observation of Samples and at Outfalls

The pulp silo drain could not be clearly observed. Samples of the silo drainage contained small amounts of recognizable pulp.

Table E-5

Franklin County Sugar Co.

Summary of Flow and Temperature Data

Date	Flow (CFS) Range	Flow (CFS) Mean	Temperature (°C) Range	Temperature (°C) Mean
Worm Creek (Station FA)				
14 Nov	------	------	10°—19°	15°
Main Sewer (Station FB)				
14 Nov	6.8-8.3	7.8	------	------
16 Nov	6.5-11.7	8.8	10°-18°	14°
17 Nov	5.7-9.2	8.2	11°-20°	15°
18 Nov	8.3-10.2	9.0	10°-18°	15°
Silage Drain (Station FC)				
16 Nov	------	------	------	30°
17 Nov	------	------	30°-32°	31°
18 Nov	------	------	32°	32°
19 Nov	------	0.51	------	------

On December 12, two weeks after refinery operation had been terminated flow in the pulp silo drain appeared appreciable. The main sewer sample contained some recognizable pulp on 17 November. The main sewer carried bits of leaves, cinders and lime throughout the survey.

Discussion

The main sewer, carrying all plant wastes except silage drainage, discharged from 4170 to 5018 gallons per ton with a mean of 4640 gallons per ton of beets processed during the survey. This compares reasonably well with the representative total of 4110 gallons per ton for flume water, pulp screen water, and lime cake slurry cited in the Public Health Service Industrial Waste Guide to the Beet Sugar Industry[2]. The B.O.D. concentration ranged from 342 to 1490 ppm with a mean of 776 ppm. On only one day when the concentration was 1490 ppm was the representative value[2] of 493 ppm materially exceeded. On this day recognizable bits of pulp were visable in the outfall, which could be indicative of defective pulp screen operation. An unusually low pH and suspended solids content were observed on this day also, which probably indicate an abnormally low lime slurry discharge. The B.O.D. load carried by this sewer ranged from 14.3 to 51.8 pounds per ton of beets processed with a mean of 28.6 pounds per ton. This is somewhat higher than the representative value given by the Guide[2] of 14.7 pounds of B.O.D. per ton of beets. Severe weather conditions complicating plant operational procedure and probably resulting in increased quantities of frozen beets in the sewer may have been partially responsible for the increased B.O.D. The mean suspended solids concentration was 3540 ppm which compares well with the representative values[2].

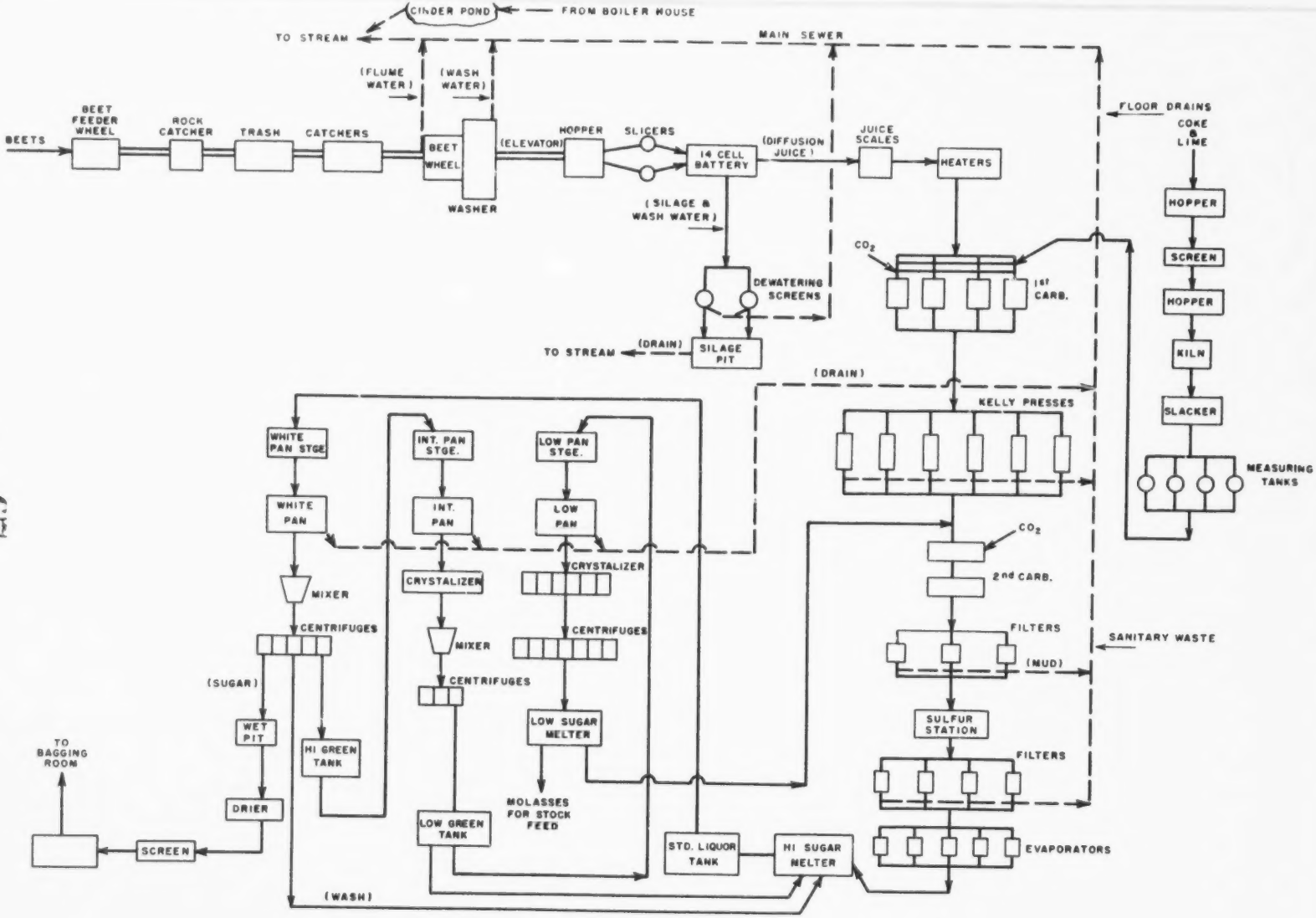
The silage drain had a discharge ranging from 260 to 291 gallons per ton of beets processed with a mean of 273 gallons per ton. This compares well with data cited in the Guide[2]. The B.O.D. concentration ranged from 5580 to 12,100 ppm. This is consistent with representative values[2]. The B.O.D. discharged in pounds per ton of beets processed ranged from 12.1 to 29.1 with a mean of 19.9. This is somewhat higher than the representative value[2] of 12.3 pounds per ton of beets. The suspended solids concentration ranged from 240 to 1150 ppm with a mean of 613 ppm which is also higher than the Guide value[2] of 270 ppm, indicating probably a slightly greater pulp loss than necessary.

The mean total waste discharged from the plant was 4913 gallons and 48.5 pounds of 5-day B.O.D. per ton of beets processed. This would indicate for the 1955 campaign with average beet processing at 1331 tons daily a mean total daily discharge of 64,554 pounds of B.O.D. or a population equivalent of 379,730. A summary of the individual waste loads is shown in Table E-6.

Table E-6

Waste Loads and Volumes - Franklin Co. Sugar Co.

Date	Tons Beets	Flow (CFS)	Flow (MGD)	B.O.D. #/Day	B.O.D. #/Ton	Flow Gal/Ton
FB - Main Sewer - Flume water + pulp screen water + beet washing water + lime waste + misc. wastes						
Nov.16	1134	8.8	5.69	16,230	14.3	5018
Nov.17	1271	8.2	5.30	65,894	51.8	4170
Nov.18	1230	9.0	5.82	24,075	19.6	4732
Mean	1212	8.7	5.60	35,400	28.6	4640
FC - Silage Drain						
Nov.16	1134	0.51	.330	33,006	29.1	291
Nov.17	1271	0.51	.330	15,348	12.1	260
Nov.18	1230	0.51	.330	22,719	18.5	268
Mean	1212	0.51	.330	23,691	19.9	273
Mean Total	1212	9.2	5.93	59,091	48.5	4913



FLOW DIAGRAM – FRANKLIN CO. SUGAR CO.
WHITNEY, IDAHO

FIGURE E 2

REPORT OF SURVEY OF AMALGAMATED SUGAR COMPANY PLANT, LEWISTON, UTAH

November 21 - 25

Collection of Information

The information reported here is the result of observation of plant operation by C. K. Sudweeks, Utah State Dept. of Health, and A. E. Becher, PHS and conferences with Mr. K. E. Bailey, plant superintendent and Mr. J. E. Smith, Chemist. Flow data collection and sampling were carried out by a plant employee assigned to that particular job. Plant officials were extremely cooperative in supplying information about plant operation, installing flow measuring devices and providing sampling help.

Plant Operation

The Amalgamated Sugar Co. plant at Lewiston, Utah, employs the Steffen process for the production of approximately 260 tons per day of ungraded bagged white sugar. The plant handles about 1770 tons of beets and 77 tons of foreign molasses per day. Discard molasses amount to about 33 T per day. Water consumption is approximately 3600 GPM from the Cub River for flume water and 1350 GPM from High Creek for battery and potable water. Other materials used include 7.3% lime, 9.6% coal, 0.5% coke (on beets). The plant has a fourteen cell bottom-dump battery of 324 cubic foot capacity cells. Production of sugar lasts for about 45 days and is on a continuous 24-hour schedule. About 236 persons are employed on three shifts.

Beet cutting for the 1955 campaign was begun at 10:00 AM on October 12 and finished at 10:15 PM on November 29. The last sugar was

out of the plant December 3. A total of 84,458 tons of beets was processed during the campaign. Beets processed on the days of the survey were:

November 21	1,790 tons
November 23	1,560 tons
November 24	1,538 tons
November 25	1,604 tons

Waste Disposal

All plant wastes are discharged to the Cub River. Several of these outfalls of minor importance are in addition to the four sampled and gauged. Sanitary sewage is discharged through three outfalls serving the office, factory, and a summer labor camp, respectively. Outfalls from the boiler room are located just above the point of discharge of flume water to the river. These include:

a 6" steel line from base of smoke stack for cinders

a 10" vitrified tile line which is the main cinder line

an 8" concrete line for boiler blow-off

The pans may be drained once or twice per campaign and this also is done through a separate outfall.

The main plant sewer carries flume water, beet washing water, silage screen water, wash water from the CO_2 gas washer, filter cloth wash water, and possibly a few floor drains. No other accidental or deliberate waste discharges can be carried by this sewer. The Steffen house sewer carries only hot Steffen waste. Lime waste is discharged to a lagoon which appears reasonably effective at removing suspended particles. Overflow from this lagoon is discharged to the river.

It is also possible to discharge pulp from the pulp silage pit to the lagoon and there was evidence during the survey of recent discharge. The frequency of this pulp discharge is not known. Pulp is normally carried to the silage pit in the battery wash water where a dewatering screen partially separates the water from the pulp. The pulp goes to the silo and the water separated to the main sewer. The pulp silo drain carries only drainage from the silage pit.

Condensate from evaporator steam chests is not discharged directly to the sewer. It goes to condensate tanks from which it is distributed to general hot water supply, boiler feed water, battery supply and Oliver filter spray water.

Chemical Data

Samples for chemical analysis were collected at each of the following outfalls:

Main sewer - carrying flume wash and pulp screen water

Steffen House sewer - carrying hot Steffen waste

Silage drain - carrying only pulp silo drainage

Lime pond drainage

Composites were made to cover an eight-hour period, and uniform 400 ml samples were collected for that purpose at hourly intervals from 5:00 AM through 12:00 noon. Uniform samples were composited because of the nearly constant flow in all but the main sewer outfall. Fluctuations in flow in the main sewer were the result of damming in the flume caused by beets getting caught, and do not reflect either variations in water consumption or waste character.

Chemical determinations run on all composites included:

pH

Alkalinity

B.O.D. (5-day)

Total solids

Settleable solids

Total suspended solids

Samples were collected on 21, 23, 24, and 25 November. Analytical results are shown in Table E-7.

Flow Data

Data were collected at hourly intervals during sampling. The main sewer was provided with a 24" metal Parshall flume and the other three outfalls with 90° V-notch weirs. All flow measuring devices were of adequate size and proper design. On November 24 a continuous water level recorder was installed at the main sewer flume to obtain a more detailed picture of flows there. Data are summarized in Table E-8.

Observations of Outfalls and Samples

The main sewer could be seen to carry bits of leaves and pulp. Pulp is believed to have been washed into the flume from railroad cars with the beets. Pulp could have entered with the pulp screen water, however. The hot Steffen waste was reddish-brown in color and carried a brownish-gray precipitate. The silage drain carried some bits of pulp but not an excessive amount by comparison to other plants. The lime pond waste carried very little settleable matter.

Table E-7

TABULATION OF CHEMICAL DATA

AMALGAMATED SUGAR COMPANY

STATION No.	STATION Description	DATE	MEAN TEMP. °C	MEAN DISCHARGE (cfs)	SOLIDS (ppm) Total	SOLIDS (ppm) Susp.	SOLIDS (ppm) Settleable m/l.	pH	ALKALINITY (ppm) Phenol	ALKALINITY (ppm) Total	B. O. D. (ppm)	B. O. D. #/day	REMARKS
AA	Main Sewer - Flume and wash water	11-21	17	9.47	1,890	976	8.0	7.9	0	325	380	19,900	
		11-23	14	10.06	3,340	3,160	10	7.8	0	334	416	22,500	
		11-24	14	10.78	2,520	1,800	8.0	8.8	13.4	380	329	19,070	
		11-25	13	10.22	3,980	2,930	9.5	7.8	0	372	331	18,200	
		MEAN	15	10.13	2,933	2,217	8.8	8.1	3.4	353	364	19,918	
AB	Steffen House Sewer	11-21	78	0.480	21,300	116	84	12.8	4,680	5,620	11,200	28,900	
		11-23	78	0.490	21,300	184	76	12.6	4,570	5,650	10,125	26,800	
		11-24	78	0.448	22,600	304	-	12.6	4,930	6,000	7,650	18,440	
		11-25	80	0.405	24,700	148	28	12.7	5,300	6,470	9,830	21,400	
		MEAN	79	0.456	22,475	188	63	12.7	4,870	5,935	9,701	23,885	
AC	Silage Drain	11-21	48	0.862	4,530	288	4.0	4.1	116 *	689**	4,130	19,150	
		11-23	48	0.696	4,300	424	35	4.2	58.8*	793**	3,830	14,350	
		11-24	48	0.633	4,640	568	6.0	4.2	80.8*	870**	3,550	12,090	
		11-25	48	0.692	5,110	544	18	4.2	63.2*	804**	3,310	12,330	
		MEAN	48	0.721	4,645	456	15	4.2	79.7*	789**	3,705	14,480	
AD	Lime Pond Drain	11-21	16	0.149	2,090	104	0.1	6.6	0	468	1,070	858	Evidence of
		11-23	14	0.219	1,280	13.2	0.13	9.1	25.4	470	548	646	recent
		11-24	11	0.067	1,130	37	Trace	7.5	0	328	479	173	silage
		11-25	8	0.071	1,130	44	Trace	7.3	0	308	460	176	discharge
		MEAN	12	0.127	1,408	79	<0.1	7.6	6.4	394	639	463	

* Mineral acidity ** Total acidity

Table E-8

Amalgamated Sugar Co.

Summary of Flow and Temperature Data

Date	Flow (CFS) Range	Flow (CFS) Mean	Temperature (°C) Range	Temperature (°C) Mean
Main Sewer (Station AA) (The recorder showed sudden highs rapidly followed by lows occurring at 15 to 30 minute intervals. The range of flows was from 5.12 cfs to 14.85 cfs with a mean of about 10.34 cfs)				
Nov. 21	7.51-12.44	9.47	14°-21°	17°
23	7.63-12.30	10.06	12°-15°	14°
24	9.54-13.63	10.78	11°-17°	14°
25	8.50-11.87	10.22	11°-15°	13°
Steffen House Sewer (Sta. AB)				
Nov. 21	0.36-0.54	0.480	77°-80°	78°
23	0.45-0.56	0.492	77°-80°	78°
24	0.40-0.54	0.448	75°-80°	78°
25	0.32-0.49	0.405	79°-81°	80°
Silage Drain (Sta. AC)				
Nov. 21	0.62-1.22	0.862	47°-49.5°	48°
23	0.64-0.76	0.696	48°-49°	48°
24	0.54-0.79	0.633	47°-48°	48°
25	0.56-0.79	0.692	48°-49°	48°
Lime Pond Drain (Sta. AD)				
Nov. 21	0.11-0.18	0.149	16°-16.5°	16°
23	0.16-0.26	0.219	13°-15°	14°
24	0.033-0.115	0.067	10°-12°	11°
25	0.058-0.080	0.071	7°-8°	8°

Discussion

Waste discharged from the main sewer ranged from 3419 to 4532 gallons per ton of beets processed with a mean of 4060 gallons. This is somewhat higher than the representative value of 2840 gallons per ton of beets cited in the Public Health Service Industrial Waste Guide to the Beet Sugar Industry[2] for flume water and pulp screen water. The higher value for this plant may be at least partially attributed to the miscellaneous wastes also discharged to this sewer. The concentration of 5-day B.O.D. ranged from 331 to 416 ppm with a mean of 364 ppm. This is also higher than the representative value indicated[1] of 275 ppm. The total pounds of B.O.D. carried by this sewer ranged from 11.1 to 14.4 pounds per ton of beets processed with a mean of 12.3. This is considerably higher than the Guide[2] figure of 6.5 pounds per ton of beets. The miscellaneous wastes discharged to this sewer as well as severe weather conditions resulting in a probable higher proportion of frozen beets may have contributed to the higher B.O.D. load. Suspended solids concentrations ranged from 976 to 3160 ppm with a mean for the survey of 2217 ppm. A suspended solids concentration of only 275 ppm is indicated by the Waste Guide[2] based on a flow of 2840 gallons per ton of beets. The much higher concentration in this case in spite of higher flows could have resulted from a higher proportion of frozen beets and from pulp washed from railroad cars or carried in with the pulp screen water.

The Steffen house sewer carrying hot Steffen waste had a mean discharge of 182 gallons per ton of beets processed and a mean 5-day B.O.D. load of 14.7 pounds per ton of beets. These quantities are normally

expressed per ton of molasses processed. Data on total molasses processed were not available at the time of this writing. Based on a foreign molasses consumption of 77 tons per day this waste load would not appear to be excessive. The mean B.O.D. concentration was 9,701 ppm which compares favorably with a representative[2] value of 10,500 ppm. The mean suspended solids concentration was 188 ppm which is well within the representative range[2].

The pulp silo drain had a flow ranging from 266 to 311 gallons per ton of beets processed with a meanof 286 gallons per ton. Considering the variability of this waste with respect to volume, this compares reasonably well with the Guide representative value[2] of 210 gallons per ton of beets. The 5-day B.O.D. concentration in the waste ranged from 3310 ppm, and the total B.O.D. load from 7.7 to 10.7 pounds per ton of beets processed with a mean of 8.9 pounds per ton. These are both within the representative [2] range. The suspended solids concentration ranged from 288 to 568 ppm with a mean of 456 ppm. This represents a slightly higher solids loss than is indicated by the figure of 270 ppm given by The Industrial Waste Guide[2].

The lime pond effluent discharge ranged from 28.6 to 90.7 gallons per ton of beets processed which compares favorably with the representative values[2]. Concentration of 5-day B.O.D. ranged from 460 to 1070 ppm with a mean of 639 ppm, and B.O.D. load from 0.11 to 0.48 pounds per ton of beets with a mean of 0.28 pounds per ton. These values also compare favorably with the representative values[2]. Suspended solids concentration ranged from 1130 to 2090 ppm with a mean of 1408 ppm.

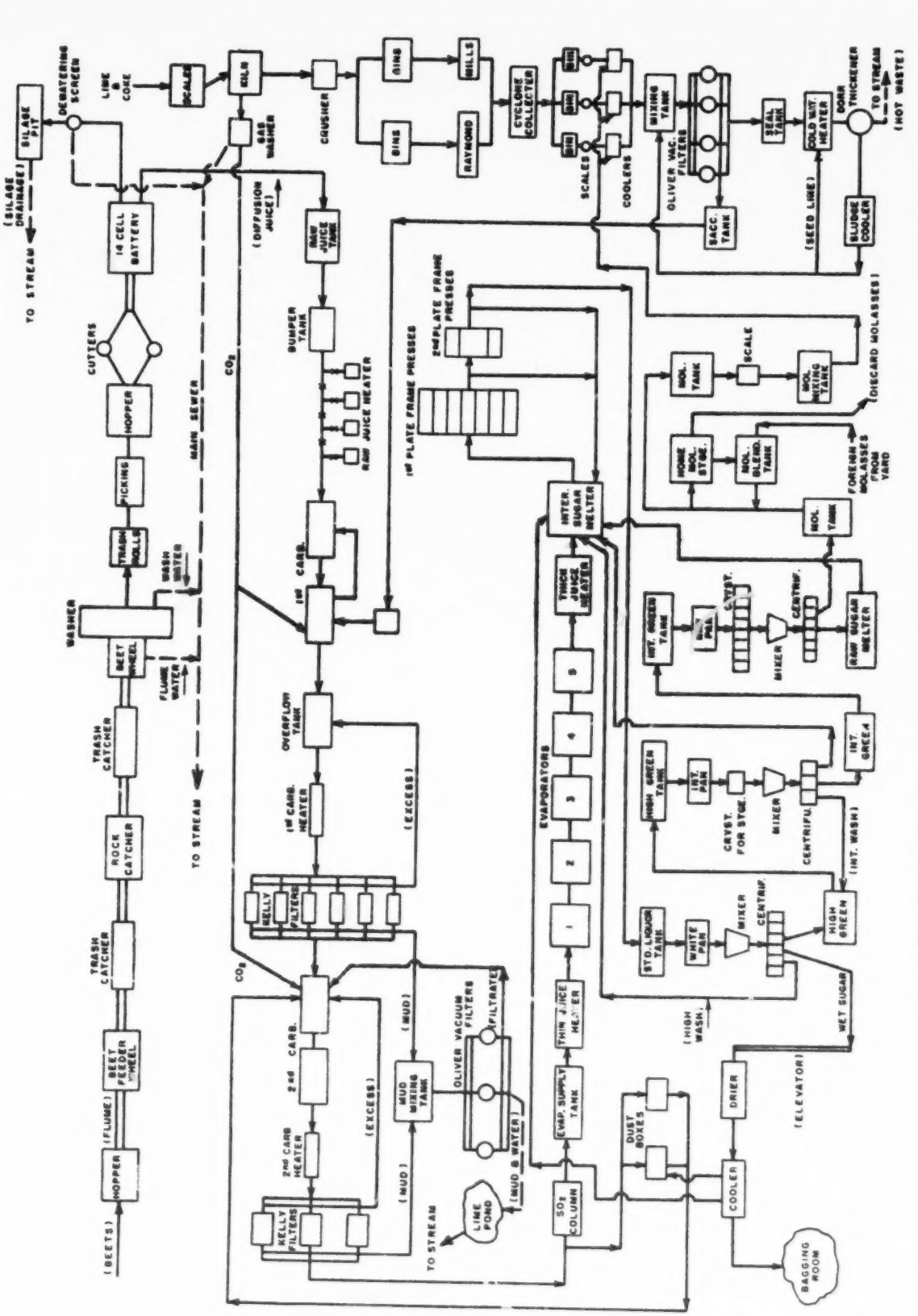
This is somewhat higher than the representative value cited in the Guide[2] of 450 ppm. A silage discharge to the pond which evidently occurred on or before the first day of sampling probably influenced the results somewhat.

The mean total waste discharged from this plant during the survey period was 4579 gallons and 36.2 pounds of 5-day B.O.D. per ton of beets processed. This would indicate for the 53 days of the 1955 campaign with average beet processing at 1594 tons per day a mean total discharge of 57,703 pounds of B.O.D. daily or a population equivalent of 339,430. A summary of individual waste loads and volumes is shown on Table E-9.

Table E-9

Waste Loads and Volumes - Amalgamated Sugar Co.

Date	Tons Beets	Flow (CFS)	Flow (MGD)	B.O.D. #/Day	B.O.D. #/Ton	Flow Gal/Ton
AA - Main Sewer - Flume water + pulp screen water + wash water + misc. wastes						
Nov.21	1,790	9.47	6.12	19,900	11.1	3419
Nov.23	1,560	10.06	6.50	22,500	14.4	4167
Nov.24	1,538	10.78	6.97	19,070	12.4	4532
Nov.25	1,604	10.22	6.61	18,200	11.3	4121
Mean	1,623	10.13	6.55	19,918	12.3	4060
AB - Steffen House Sewer - Hot Steffen waste						
Nov.21	1,790	0.480	.310	28,900	16.1	173
Nov.23	1,560	0.490	.317	26,800	17.2	203
Nov.24	1,538	0.448	.290	18,440	12.0	189
Nov.25	1,604	0.405	.262	21,400	13.3	163
Mean	1,623	0.456	.295	23,885	14.7	182
AC - Silage Drain						
Nov.21	1,790	0.862	.557	19,150	10.7	311
Nov.23	1,560	0.696	.450	14,350	9.2	288
Nov.24	1,538	0.633	.409	12,090	7.8	266
Nov.25	1,604	0.692	.447	12,330	7.7	279
Mean	1,623	0.721	.466	14,480	8.9	286
AD - Lime Pond Drain						
Nov.21	1,790	0.149	.0963	858	0.48	53.8
Nov.23	1,560	0.219	.1415	646	0.41	90.7
Nov.24	1,538	0.067	.043	173	0.11	30.1
Nov.25	1,604	0.071	.0459	176	0.11	28.6
Mean	1,623	0.127	.0818	463	0.28	50.8
Mean Total	1,623	11.4	7.39	58,746	36.2	4579



FLOW DIAGRAM – AMALGAMATED SUGAR CO.
LEWISTON, UTAH

FIGURE E 3

REPORT OF SURVEY OF SEGO MILK CO., RICHMOND, UTAH

November 28 - December 2, 1955

Collection of Information

The information reported here is the result of observation of plant operation by C. K. Sudweeks, Utah State Dept. of Health and A. E. Becher, PHS and conferences with the following plant officials:

Albert L. Kirsher, Plant Manager

Herbert G. Taylor, Asst. Plant Manager

Harry M. Watts, Second Asst. Plant Manager

Flow data collection and sampling were carried out by a plant employee under direction of PHS and Utah Dept. of Health personnel. Plant officials had a weir installed for flow measurement and were extremely cooperative in supplying sampling assistance and information.

Plant Operation

The Sego Milk Co. plant at Richmond receives approximately 130,000 pounds per day of raw milk for the production of condensed milk. Cream is purchased separately to adjust butter fat content. Normally 60,000 pounds of milk per day are received in cans and 70,000 pounds per day in tank trucks. Raw milk is received and condensed on seven days per week, but canning is done only on Monday thru Saturday. Milk condensed on Sunday is distributed over the other six days for canning. Canning takes place from 6:15 AM to 5:45 PM Monday thru Saturday. Raw milk is received daily from 7:00 AM to 12:30 PM. The washup is completed by approximately 4:00 PM. Cans are manufactured Monday thru Saturday from 7:00 AM to 6:30 PM. Maximum plant capacity is about 260,000 pounds per day of raw

milk or 117,000 pounds of condensed milk. The plant water supply is from a company owned spring except for drinking water and some supplementary water which is from the Richmond City system. Water consumption is not metered. Under normal conditions approximately 50 people are employed in the plant.

Plant production in terms of raw milk for the period of the survey was:

November 28	210,000 lbs.
November 30	210,000 lbs.
December 1	260,000 lbs.
December 2	260,000 lbs.

During this period the plant employed 84 persons.

Waste Disposal:

Plant wastes are discharged to the two sewers gaged and sampled in this survey, and no by-pass sewers are known to exist. Direct sewer connections exist to the can washer, evaporators, steam sterilizers, can coolers, and pre-heaters. Boiler blowoff is discharged to the sewer and cinder slurry is also pumped to the sewer for about 10 minutes once daily. 16 floor drains discharging to the sewer are distributed thru the plant as follows:

Filler Room	2
Evaporator Storage Tank Room	2
Evaporator Room	2
Receiving Platform	2
Sample Bottle Room	1

Processing Room 5

Labeling Room 1

Boiler Room 1

The plant sewers also receive all sanitary sewage from the plant. The hot wells are cleaned each morning before 7:00 AM with a 1% acid solution followed by a 1% caustic solution. The solutions are reused as long as possible with daily additions to keep strength and volume up. After use each day the solutions are settled and sludge drained to the sewer. An estimated 15 pounds of acid and 25 pounds of caustic are discharged daily. For other cleaning washing powder, not soap, is used and discharged to the sewer.

No special waste treatment or prevention facilities are incorporated in the plant. The evaporators have no special entrainment prevention features. The height and design of the evaporators, and experienced operation are considered sufficient to prevent excessive entrainment. Can drippings are collected for hog feed.

Chemical Data

Samples for chemical analysis were collected over the weir installed at the confluence of the two plant outfalls at 20 minute intervals and composited in proportion to discharge. Composites were made to cover the entire daily period of plant operation and were collected from 7:00 AM thru 4:30 PM. Determinations made on each composite included:

pH

5-Day B.O.D.

Alkalinity

Total Solids

Total Suspended Solids

Settleable Solids

Samples were collected on 28 and 30 November and 1 and 2 December 1955. Analytical results are shown in Table E-10.

Flow Data

An 18" rectangular weir of adequate design and construction was installed in the channel receiving the discharge from both plant sewers. Flows were obtained by means of staff gauge readings taken at twenty minute intervals from 7:00 AM thru 4:00 PM on all sampling days. Flows were also obtained for the period 7:00 AM November 28 to 4:00 PM December 1 by means of a continuous water level recorder. Waste discharge for the day of November 30, apparently a typical day, is shown in Figure E-4. Flows and temperatures based on the twenty minute observations are summarized in Table E-11.

Observations of Samples and Outfall

The appearance of the waste at the outfall changed frequently throughout the operating day, ranging from a clear to a highly cloudy appearance. The composite samples had a slightly milky appearance.

Discussion

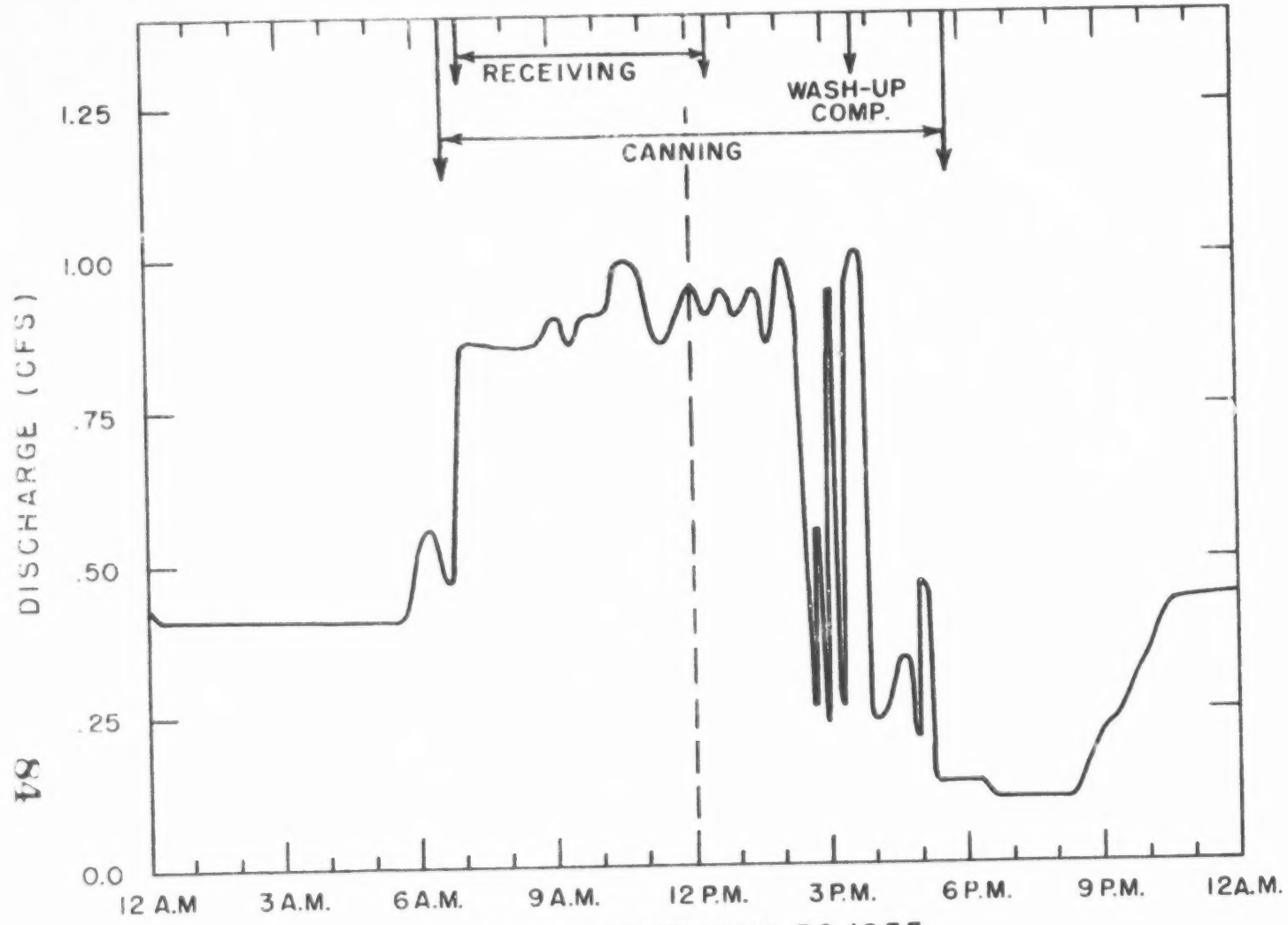
The total B.O.D. discharged per day from the plant ranged from 76.7 to 120.0 pounds with a mean of 103.2 pounds during the period of the survey. This represents from 3.0 to 5.2 pounds of B.O.D. per 10,000

Table E-10

Tabulation of Data

SEGO MILK COMPANY

STATION No.	STATION Description	DATE	MEAN TEMP. (°C)	MEAN DISCHARGE (cfs)	SOLIDS (ppm) Total	SOLIDS (ppm) Susp.	SOLIDS (ppm) Settleable (Ml/L	pH	ALKALINITY (ppm) Phenol	ALKALINITY (ppm) Total	B.O.D. (ppm)	B.O.D. #/day	MILK Processed (10000#)	#BOD/10000#	REMARKS
SA	Sego Milk Co.	Nov.28	37	0.849	389	43.2	Trace	7.3	0	188	63.8	109.6	21	5.2	
	Combined Outfall	Nov.30	42	0.823	352	40.8	<0.1	8.2	0	206	63.8	106.2	21	5.1	
		Dec.1	39	0.892	462	111	<0.1	8.6	7.60	226	42.5	76.7	26	3.0	
		Dec.2	37	0.969	385	73.0	<0.1	7.7	0	195	61.3	120.1	26	4.6	
		Mean	39	0.883	397	67.0	<0.1	8.0	1.9	204	57.9	103.2	24	4.5	



WASTE DISCHARGE
SEGO MILK CO.

FIGURE E4

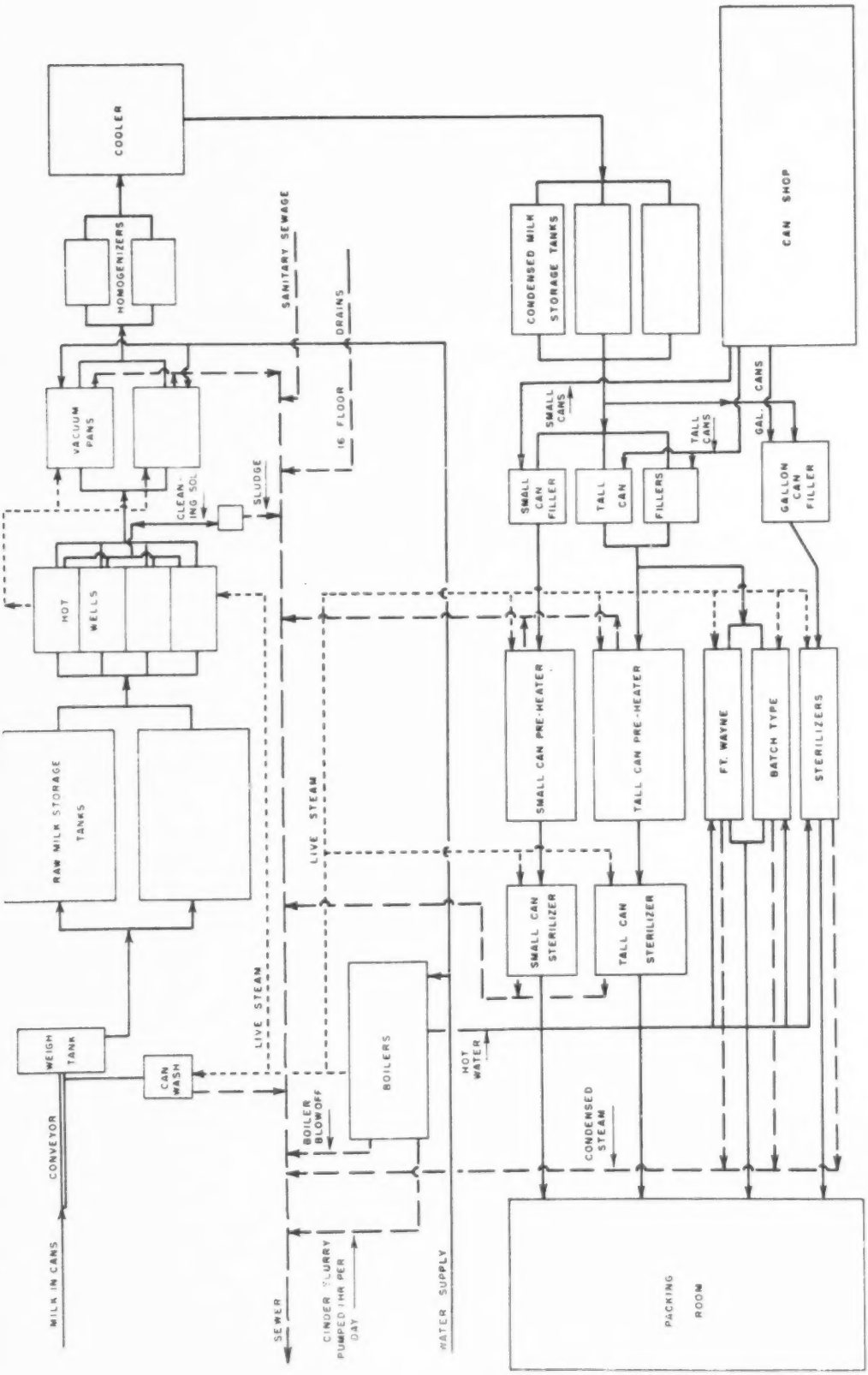
Table E-11

Summary of Flow and Temperature Data - Sego Milk Co.

(Station SA)

	Discharge (CFS)		Temperature (°C)	
Date	Range	Mean	Range	Mean
Nov.28	.284 - 1.28	.849	18° - 44°	37°
Nov.30	.257 - 1.03	.823	34° - 50°	42°
Dec. 1	.257 - 1.37	.892	20° - 48°	39°
Dec. 2	.500 - 1.33	.969	18° - 44°	37°

pounds of raw milk processed. A population equivalent of 607 is indicated by the survey data. These results are somewhat below those to be expected from experience with similar plants but no explanation is apparent.



FLOW DIAGRAM - SEGO MILK CO.
RICHMOND, UTAH

FIGURE E 5

REPORT OF SURVEY OF ROCKY MOUNTAIN DAIRY PRODUCTS CO.

SMITHFIELD, UTAH

December 5 - 8, 1955

Collection of Information

The information reported here is the result of observation of plant operation by C. K. Sudweeks, Utah State Dept. of Health and A. E. Becher, PHS and conferences with Messrs. Gossner and Hansen, Rocky Mt. Dairy Products Co. Sampling was carried out by plant employees under direction of PHS and Utah Dept. of Health personnel. Plant officials had a weir installed for flow measurement and were helpful in supplying information about plant processes.

Plant Operation

The Rocky Mountain Dairy Products plant at Smithfield, Utah, produces cheese, cottage cheese, bottled milk, cream, powdered milk, powdered whey and butter. For the year 1955 production was highest in May and June at 7,700,000 pounds of raw milk intake per month and lowest in November and December at 3,900,000 pounds per month. Under normal conditions approximately 90,000 pounds per day of Grade A milk are received daily. Of this, 50,000 pounds are received in cans and 40,000 pounds in tank trucks. 32,000 to 33,000 pounds daily are used in the plant for bottling and cottage cheese production, and the rest is shipped to Ogden, Utah, for processing there. About 4,000 pounds per day of butterfat are separated and most of it shipped as cream with a small amount processed at the plant into butter. The remainder of milk processed at the plant is Grade C milk from which cheese is made.

All whey from the production of cheese is evaporated to powder of 2 1/2% to 5 1/2% moisture content. Buttermilk from the production of butter is also powdered. Powdered whey and buttermilk are used for stock food supplement and similar purposes. A small amount of milk is powdered, and this operation is carried on about 20 days per year.

During the period of this survey production in terms of pounds of raw milk processed was as follows:

Date	Grade A Milk (lbs. raw milk)	Milk Received for Cheese making (lbs. raw milk)	Cheese Production (lbs. raw milk)
Dec. 5	48,000	129,000	0
Dec. 6	0	132,000	175,000
Dec. 7	62,000	132,000	175,000
Dec. 8	0	132,000	175,000

During the month of November a total of 210,000 pounds of whey as powder were evaporated.

Milk is bottled five days per week, usually Monday, Tuesday, Wednesday, Friday, and Saturday. Cheese is manufactured six days per week, not necessarily on the same days each week. The normal operating schedule is:

7:00 AM	Bottling begins
8:00	Dumping milk
9:00	Cheese making
12:00 Noon	Making concentrated whey
4:00 PM	Bottling finished, wash-up begins
12:00 Midnite	All operations cease

The plant uses approximately 90,000 gallons per day of culinary water. Other water is used, principally for cooling, from the river, but it is not metered. A total of 130 persons are employed at this plant.

Waste Disposal

All plant wastes are discharged to the plant sewer gauged and sampled in this survey, and no by-pass sewers are known to exist. Waste from the evaporators, boiler blowoff and cooling water may be discharged directly. Sanitary sewage from the plant and two homes on the grounds is discharged untreated to the plant sewer. Washings from a small barn are also discharged to the plant sewer. All other wastes must reach the sewer thru one of the 34 floor drains in the plant. Included in these wastes is caustic from the bottle washers which is discharged periodically.

Except for collection of can drippings, no special waste saving or waste treatment practices are in use. No special entrainment prevention features have been considered necessary for the vacuum pans because of their height and continuous flow design. Because the boilers are oil fired no cinder waste is discharged.

Chemical Data

Samples for chemical analysis were collected at a manhole in the outfall line at twenty minute intervals. These samples were stored in separate bottles for later compositing in proportion to flow. Composites were made to cover the entire daily period of operation. On December 5 when no cheese was made the sample was composited from 8:00 AM thru 6:00 PM. On December 6, 7, and 8 samples were composited from 8:00 AM

thru 12:00 midnite. Determinations on each composite included:

pH

5-day B.O.D.

Alkalinity

Total Solids

Total Suspended Solids

Settleable Solids

Analytical results are shown in Table E-12.

Flow Data

Flow data were collected by means of an 13" rectangular weir and a continuous water level recorder installed in a channel receiving the discharge from the plant sewer approximately a half mile below the manhole sampled. The approximate time lag between manhole and weir was determined by timing the travel of small floats from one point to the other. A correction for this time lag which was ten minutes was applied to data from the recorder for proportioning composites.

On December 7 shortly before the end of sampling the weir was washed out. On the morning of December 8 the weir was repaired but was washed out again two hours later. The means of the individual flows on December 6 and 7 were used in compositing the sample for the 8th. Flow and temperature data are summarized in Table E-13. Typical discharge patterns for Grade A dairy operation and cheese making operation are shown in Figure E-6.

Table E-12

Tabulation of Data

ROCKY MOUNTAIN DAIRY PRODUCTS COMPANY

STATION No.	STATION Description	DATE	MEAN TEMP. (°C)	MEAN DISCHARGE (cfs)	SOLIDS (ppm) Total	SOLIDS (ppm) Susp.	SOLIDS (ppm) Settle-able (Ml/L)	pH	ALKALINITY (ppm) Phenol	ALKALINITY (ppm) Total	B.O.D. (ppm)	B.O.D. #/day	MILK Proc-essed (10000#)	#BOD/ 10000#	REMARKS
RA	Rocky Mt. Dairy Products Company	Dec.5*	12	.902	1020	334	0.6	9.6	84.1	463	258	523	4.8	109	10 Hour Composite
		Dec.6	17	1.206	973	98	0.24	8.9	24.1	352	255	1106	17.5	63.2	
	Combined Outfall	Dec.7	19	1.119	1160	248	0.65	9.5	86.0	444	300	1207	23.7	50.9	
		Dec.8	16	1.168	1020	88	<0.1	8.6	17.8	349	196	823	17.5	47.0	Flow estimated from 6 and 7
		Mean	17	1.164	1051	145	0.30	9.0	42.6	382	250	1045	19.6	53.7	

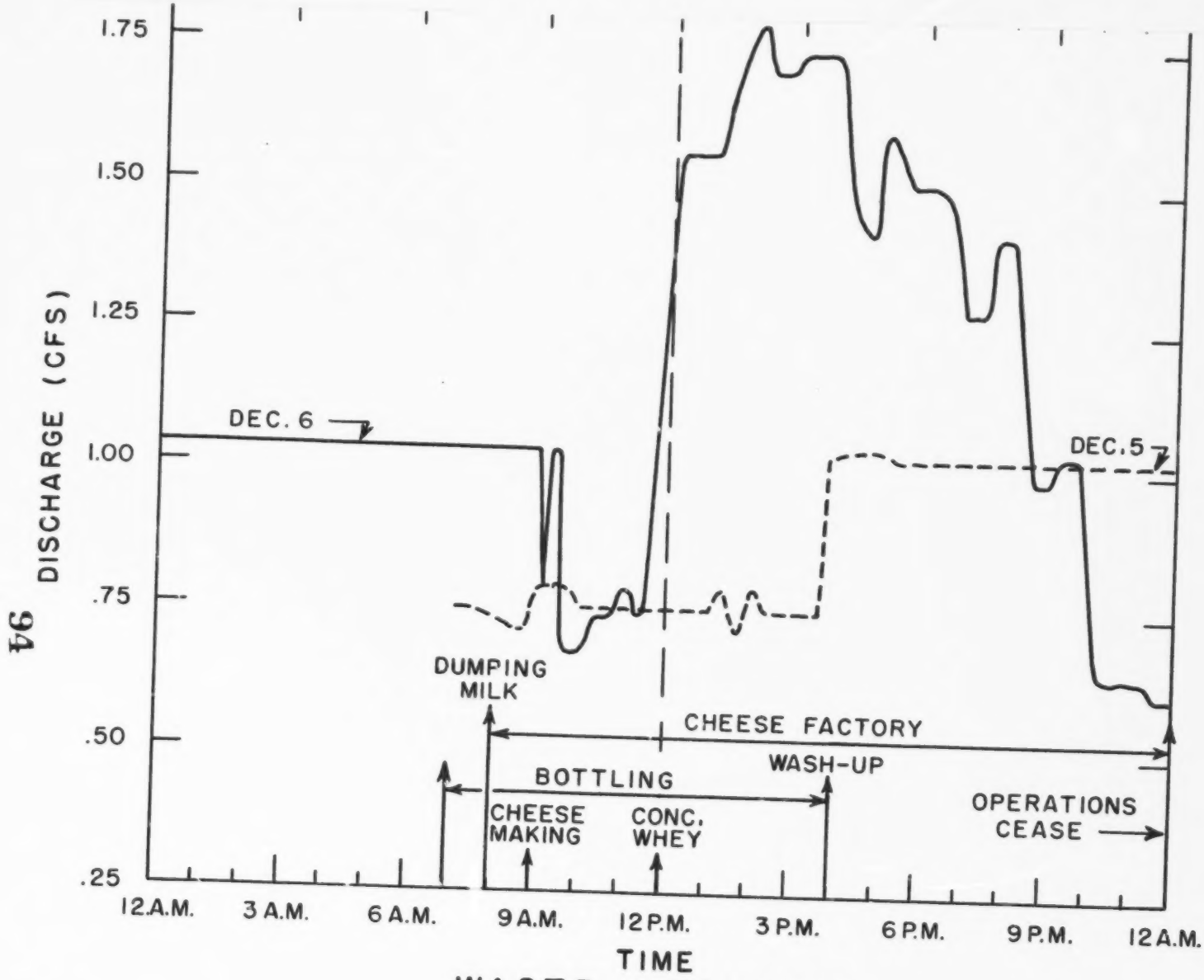
* No Cheese making - Not included in Means

Table E-13

Rocky Mountain Dairy Products Co. - Summary of Flow and Temperature Data

	Flow (CFS)		Temperature (°C)	
Date	Range	Mean	Range	Mean
Dec. 5	.712 - 1.44	.902	8° - 21°	12°
Dec. 6	.603 - 1.79	1.206	6° - 31°	17°
Dec. 7	.603 - 1.94	1.119	10° - 37°	19°
Dec. 8	--	1.168*	6° - 37°	16°

* Estimated

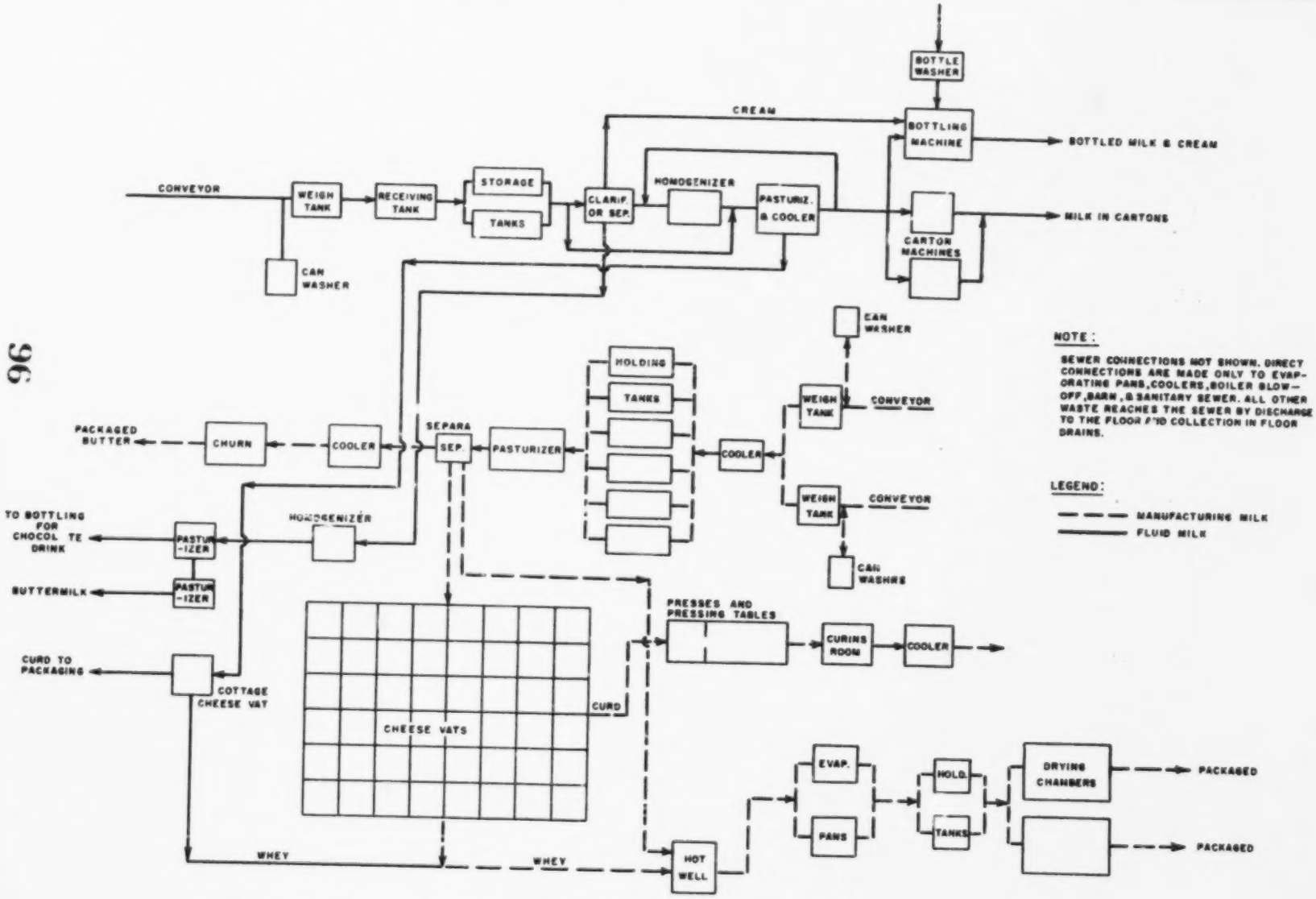


WASTE DISCHARGE
ROCKY MT. DAIRY PRODUCTS CO.

FIGURE E6

Discussion

On December 5 when only the Grade A dairy was in operation 523 pounds of 5-day B.O.D. were discharged or 109 pounds per 10,000 pounds of raw milk processed. On December 6 when only the cheese making operation was in progress 1106 pounds of B.O.D. or 63.2 pounds per 10,000 pounds of raw milk processed were discharged. On December 7 when both processes were being carried on 1207 pounds of B.O.D. or 50.9 pounds per 10,000 pounds of milk processed were discharged.. The plant had a population equivalent, based on the day of operation of both processes of 7,100. During the period of the survey waste discharges from this plant were apparently not excessive for operations of this type without waste treatment.



FLOW DIAGRAM – ROCKY MOUNTAIN DAIRY PRODUCTS CO.
SMITHFIELD, UTAH

FIGURE E 7

F - 1-A

APPENDIX F

PRINCIPAL SOURCES OF POLLUTION IN THE LOWER BEAR RIVER BASIN

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Table F-1

Principal Sources of Municipal Pollution

Lower Bear River Basin

Stream And Name	River Mi. Above Outlet Stream	Pop.Equiv. Untreated Wastes	Treatment	Pop. Equiv. Treated Waste
Bear R.				
Bear River City, Utah *	22	100	None	100
Corinne, Utah	12	500	None	500
Cub R.				
Lewiston, Utah	6	500	None	500
Worm Cr.				
Preston, Idaho	8	4000	Primary	2600
Little Bear R.				
Wellsville, Utah	16	500	None	500
Logan R.				
Logan, Utah	9	22,000	None	22,000
Malad R.				
Garland, Utah	14	900	None	900
Bear River High School, Utah	12	600	Septic Tank	550
Tremonton, Utah	11	1,662	Septic Tank	1,600

Information from 1953 Inventory(6)

* From Report on Interstate Water Pollution in The Bear River Water Shed(4)

Table F-2

Principal Sources of Industrial Pollution

Lower Bear River Basin

Stream & Waste Source	Mile Above Outlet Stream	(B.O.D.) Pop.Equiv.of Waste Discharged	Treatment	Information Source
Bear R.				
Cache Vally Creamery, Lewiston	57	2400	None	Inventory 1953 (6)
California Packing Co. Smithfield	55	35,200	Fine Screen	Inventory 1953 (6)
Rocky Mt. Dairy Co. Smithfield	58	7,100	None	This Survey
Cub R.				
California Packing Co. Franklin	9	17,300	Fine Screen	Inventory 1955 (7)
Amalgamated Sugar Co. Lewiston	6	339,430	Lagoon	This Survey
Sego Milk Co. Richmond	3	607	None	This Survey
Worm Cr.				
Franklin Co. Sugar Co. Whitney	6	379,730	None	This Survey
Malad R.				
Utah-Idaho Sugar Co. Garland	14	271,000	Lagoon, Screen	This Survey

APPENDIX G

Excerpts from

SUMMARY REPORTS ON PROPOSED

BUREAU OF RECLAMATION PROJECTS

G - 1 - A

EAST CACHE PROJECT

IDAHO and UTAH

March 1956

Prepared by Bureau of Reclamation

Excerpts from Report

SUMMARY -- EAST CACHE PROJECT

LOCATION: Eastern Cache Valley in southeastern Idaho and northern Utah, Bear River Basin.

PLAN OF DEVELOPMENT

The existing Glendale Reservoir on Worm Creek would be enlarged from its present capacity of 5,800 acre-feet to 23,000 acre-feet. Water would be brought to the reservoir from Cub River through an enlargement of the Cub-Worm Canal and from Mink Creek through the existing Mink Creek Canal. The East Cache Canal would be constructed from the reservoir south 27 miles to Smithfield to distribute project water for irrigation. Through water exchanges some lands above the canal would be irrigated, and Lewiston and other communities would be provided additional municipal water.

ANNUAL WATER SUPPLY (acre-feet)

Irrigation	14,500
Municipal	1,000
Total	15,500

IRRIGATED AREA (acres)

Supplemental service land	11,110
Full service land	2,440
Total	13,550

REPORT OF THE REGIONAL DIRECTOR

1. This report summarizes the results of investigations of the potential East Cache project by Region 4, Bureau of Reclamation. The project would consist primarily of a reservoir and canal development to meet needs for water in eastern Cache Valley in southwestern Idaho and northern Utah. Approximately 15,500 acre-feet of water would be made available annually for supplemental irrigation of 11,110 acres now without adequate water, full irrigation of 2,440 acres presently dry, and for municipal use in towns that have outgrown their water supplies.

2. Authority to make the report and supporting investigation is provided in the Federal reclamation laws (Act of June 17, 1902, 32 Stat. 388, and acts amendatory thereof or supplementary thereto). Reports of the National Park Service, Fish and Wildlife Service, Public Health Service, and Corps of Engineers on the recreational, fish and wildlife, public health, and flood control aspects of the project are appended.

3. In addition to the reports mentioned in paragraph 2, data and services furnished by the Geological Survey, Weather Bureau, Utah State College, Utah Power and Light Company, and several municipalities and irrigation organizations in the project area were utilized in the investigations. Funds contributed by the State of Utah were used in early stages of the investigations.

General Description of Area

4. The project area is in the eastern portion of Cache Valley. Encompassing 50 square miles, it extends from Preston, Idaho, south 30 miles to Logan, Utah. Elevations in the area range from 4,500 to 5,000 feet above sea level. Immediately east of the area is the Bear River Range of the Wasatch Mountains rising to elevations of 9,000 to 10,000 feet. West of the area are Bear River and the central lowlands of Cache Valley.

5. In this semiarid area, intensive agricultural operations are possible only with irrigation. Without irrigation, agricultural enterprise is restricted largely to production of cereal crops, mainly wheat and barley. Irrigation increases crop yields greatly and makes possible the production of a variety of crops, including forage crops which provide a base for dairy farming and for stockraising activities utilizing adjacent rangelands for grazing. Irrigation thus intensifies and broadens the agricultural enterprise and contributes enormously to the economy of the area.

6. Most of the water used for irrigation is obtained from several streams flowing from the mountains east of the area. The largest streams, with their average annual flows in acre-feet, are Logan River (170,000), Mink Creek (75,000), and Cub River (60,000). These streams supply water to adjacent areas as well as to the project area. Worm Creek, Maple Creek, High Creek, City Creek, Summit Creek, and other streams are much

smaller. About three-fifths of the streamflow occurs during April, May, and June. Water diverted from these mountain streams is used on lands sloping from the mountains to Bear River in the central part of the valley. Bear River, which enters Cache Valley through a canyon on the northeast and leaves through another canyon on the west, is by far the largest stream in the valley. At the point where it leaves the valley, Bear River has an average annual flow of about a million acre-feet. This stream can be utilized in the project area only by pumping, however, and furnishes water to a comparatively small part of the area situated within the range of economical pump lifts.

7. Some 20,000 years ago Cache Valley was a bay of old Lake Bonneville which covered an area now within southeastern Idaho, eastern Nevada, and the western half of Utah. Most Cache Valley soil materials consist of clay, silt, sand, and gravel carried into the lake by streams flowing from the surrounding mountains and deposited in layers and pockets. Clay and clay-loam soils predominate in the central lowlands of the valley. In some lowlands areas, however, these fine soils are covered by sandy loam and sandy soils deposited in broad lake bars. Materials deposited on the valley slopes and benches are mainly sand and gravel, covered by a layer of silt-loam soil. In numerous localities, the lake-laid materials on the valley slopes and benches have been covered by alluvial soils deposited by the mountain streams following recession of the old lake.

8. The topography of the valley is generally smooth, except where some of the larger streams flowing from the mountains have become deeply entrenched in the materials forming the valley slopes and benches. Ground surfaces vary from nearly flat to gently and moderately sloping on the benches and along the valley sides.

9. Because of the many differences in the soil material deposits, ground-water levels are variable. Over the central lowlands, the ground-water level generally is 1 to 5 feet below the ground surface. The sandy lake-bars areas, although elevated 40 to 60 feet above the lowlands, also generally have fairly high water tables (3 to 5 feet below the surface) because of underlying layers of clay. On the valley slopes and benches ground water generally lies 30 to 150 feet or more below ground surface. In numerous small areas, however, ground water on the valley slopes lies very near the surface. An artesian basin underlies an area of lowlands and lower valley slopes between Logan and Richmond, Utah. This basin is useful as a source of water for irrigation and other purposes but aggravates drainage difficulties on some of the lands in the area.

10. The frost-free period varies considerably in different localities, ranging from an average of 117 days in the central, open sections of the valley to 159 days on the benches near the mountains. Temperatures are generally moderate. Maximum and minimum temperatures of 108° F. and 32° F. have been recorded, but temperatures approach these extremes only rarely. The average annual precipitation is about 16.4 inches over the entire project area. Average precipitation during the May-September growing season ranges from 5-1/4 inches to 6 inches.

11. Permanent settlement of Cache Valley began in 1860 as an outgrowth of the earlier (1847) colonization of Salt Lake City. The present population of the valley (Franklin County, Idaho, and Cache County, Utah) is about 43,400 based on the 1950 census. The population of that portion of the valley directly affected by the East Cache project is about 30,000. The three largest towns in the valley--Logan, Utah, (16,832), Preston, Idaho (4,045), and Smithfield, Utah, (2,383)--are within this area. Other towns in the project area with populations of more than 1,000 are Lewiston (1,533) and Richmond (1,091), both in Utah.

12. The economy of the project area is based mainly on agriculture which provides direct support for 31 per cent of the population. Manufacturing, consisting mainly of processing of agricultural products, supports 8 per cent. The largest plants processing agricultural products include two beet-sugar factories (Whitney, Idaho, and Lewiston, Utah), two vegetable canneries (Franklin, Idaho, and Smithfield, Utah), two milk condenseries (Richmond and Logan, Utah), and one plant manufacturing cheese, ice cream, butter, and other dairy products (Amalga, Utah). Various construction activities support 7 per cent of the population. Transportation, communications, and utilities support 5 per cent. Practically all of the remaining population is supported by the usual variety of supply and service industries and occupations, which are based mainly on agriculture.

13. With the exception of townsites and rights-of-way for transportation facilities, practically all of the project area consists of privately owned farmland. About 60 per cent of the farmland is irrigated, cultivated, and utilized for production of alfalfa and other hay, grains, improved pasture crops, canning crops (peas, beans, and corn), sugar beets, potatoes, and specialty crops. About 15 per cent of the farmland consists of irrigated and subirrigated meadows not adapted to cultivation mainly because of dense soils and inadequate drainage. The remaining 25 per cent consists of dry land. Nearly all of the dry land is cultivated and utilized for production of those crops which can be matured without irrigation, such as wheat, some alfalfa hay and seed, and barley, with only a small portion being utilized as pasture.

14. The irrigated farms are generally rather small, averaging only about 50 acres. The most common enterprise on the irrigated lands is a combination of crop farming and dairying. Dairying is the largest source of farm income and is largely dependent on forage crops grown under irrigation. Most of the forage crops are fed to the dairy stock on the farms producing the crops. Farmers also derive a substantial portion of their income from sales of cash crops, including grains, canning crops, sugar beets, fruits and berries, potatoes, and specialty crops. A comparatively few farmers are engaged wholly in the production of field crops. A few, mainly the part-time operators of very small farms, are engaged wholly in dairying. Some raise beef cattle, utilizing adjacent rangelands for summer grazing, in addition to carrying on other enterprises. Some operators of irrigated farms also are engaged in dry farming. The dry farms, being much less productive per acre than the irrigated farms, necessarily are larger in order for their operation to be profitable. The average dry farm holding contains about 350 acres. Incomes from the dry farms are derived almost wholly from sales of crops.

15. Markets in nearby Ogden and Salt Lake City provide ready outlets for agricultural products not required for local consumption. Good transportation service to these points and others in Idaho and Wyoming and also within the project area is provided by the Union Pacific Railroad and by hard-surfaced Federal, State, and county highways. Other utility services are very good. Electric power supplies are reliable and otherwise adequate. Municipal water systems provide satisfactory distribution of culinary water, but the supplies in some cases are insufficient as explained in paragraphs 19 and 20.

16. Irrigation water is diverted from the various mountain streams in the area and is conveyed to the farms by canal systems owned and operated by approximately 15 nonprofit mutual irrigation companies organized by farmers using the water. For most of the area the annual requirement for irrigation water, properly distributed over the growing season, is 2.5 to 3 acre-feet for each acre irrigated, as measured at heads of main supply canals. The requirement of a small part of the area is only 1.6 acre-feet per acre.

17. To augment the water supplies obtained from natural flows of Mink Creek, Worm Creek, and Cub River for irrigation of land in the vicinity of Preston, three small reservoirs have been developed by irrigation companies. These are the Glendale, Lamont, and Johnson Reservoirs with active capacities of 5,800, 2,500, and 700 acre-feet, respectively. Glendale Reservoir is on Worm Creek 4 miles northeast of Preston. The others are offstream reservoirs in the same vicinity. Water stored in all three reservoirs is obtained from Worm Creek and from Cub River by feeder canals. To augment the water supplies obtained from Cub River for irrigation in the vicinity of Lewiston, a pumping plant has been constructed by an irrigation company to lift water from Bear River. Individual farmers also pump water from Bear River for a few small farms adjacent to this stream.

18. Lands served by the reservoirs and pumping facilities normally experience little or no shortage in water supply. Lands irrigated from Logan River, extending from the vicinity of Logan to Smithfield, also ordinarily do not experience substantial shortages. Practically all other irrigated lands within the project area have water shortages of from 20 to 50 per cent of their total demand in years of normal streamflow. Some 14,620 acres of partially irrigated lands have been classified as suitable for irrigation and cultivation. These lands have an average annual supplemental water requirement of 14,300 acre-feet. Dry lands that are suitable for irrigation and cultivation comprise a total of 3,650 acres and have an average annual water requirement of 8,900 acre-feet.

19. Water for most of the municipalities is diverted from natural springs and conveyed by pipelines to municipal distribution systems. Some of the springs are situated along the mountain front east of the project area. Others, such as those utilized by Logan and Preston, are several miles back in mountain canyons. Water for Logan is piped from a spring in Logan River Canyon 7 miles east of the city. Water for Preston is piped 14 miles from a spring in Cub River Canyon. Flows of most of the springs are substantially larger than the requirements of the municipalities, but

are used for irrigation as well as municipal purposes. Consequently, the water supplies now available for most of the municipalities are limited not by insufficiencies of the water sources but by water rights.

20. Water rights of some of the rapidly growing municipalities no longer meet the requirements, particularly during summers of dry years when the requirements are greater but the available supplies are smaller than usual. Logan, with a population increase of 46 per cent between 1940 and 1950, requires the largest quantity of additional water. For its present population Logan has a supplemental water requirement ranging from 100 acre-feet in normal years to 800 acre-feet in dry years. For a population of 25,000, which is anticipated within about 20 years, Logan would require a supplemental water supply estimated at 1,500 acre-feet. Lewiston, Smithfield, River Heights, and other towns require smaller quantities of supplemental water than Logan, but in proportion to their populations inadequacies in their present supplies are perhaps even more serious. To meet present requirements and to provide reserves for some growth in population, Lewiston, Smithfield, and other towns between Preston and Logan require an aggregate supplemental water supply estimated at 1,000 acre-feet.

21. One Federal reclamation project, the Preston Bench project, supplies water to lands within and adjacent to the northern end of the East Cache project area. The Preston Bench project was constructed in 1948 and 1949 to replace the failing Preston, Riverdale, and Mink Creek Canal that conveyed water from Mink Creek to lands on Preston Bench. The new canal, known as the Mink Creek Canal, is 15 miles long and includes 1,130 feet of tunnel section. It does not convey water directly to the land, as did the old canal, but delivers it to Worm Creek for subsequent distribution to the same lands through ditches diverting from that stream. Delivery to Worm Creek is made above the Glendale Reservoir.

22. Four existing hydroelectric powerplants are in the vicinity of the project area. By far the largest is the Utah Power and Light Company's 30,000-kilowatt Cutler plant in the Bear River Canyon outlet of Cache Valley. A dam in the canyon creates an effective power head of 123 feet and provides 17,000 acre-feet of storage capacity for river regulation. Three small run-of-the-river powerplants are on Logan River. Data on the four plants are tabulated below.

Name of powerplant	Owner	Stream	Installed capacity (kilowatts)
Cutler	Utah Power and Light Company	Bear River	30,000
Logan Municipal	Logan City	Logan River	1,400
Logan	Utah Power and Light Company	Logan River	2,000
Utah State	State of Utah	Logan River	450

Need for Development of Water Resources

23. The project area is comparatively rich agriculturally, with most of its land under irrigation, and in many respects is already well developed. It has, however, some serious problems associated with its

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land and water. Crop production on most of the land is restricted either by too little or too much water. Except during the spring when flows are high, streams supplying water for irrigation are too small to meet the needs of the area. Most of the irrigated land suffers water shortages every year and some land remains unirrigated because water is not available. Other lands are too wet throughout the growing season because of high water tables and inadequate drainage. Culinary water supplies are becoming insufficient for growing towns. Flood damages are relatively small, but flood control measures on some of the streams would be beneficial.

24. Agricultural expansion in the project area virtually ceased years ago when all available natural streamflows had been put to use. Any increase in farm production since that time has resulted from improvements in farm equipment or from improved farm practices and techniques.

25. Because of the variable and generally inadequate water supplies obtainable from the natural streamflows, crop production on the irrigated lands is unsatisfactory. Crop production is lower still on the dry lands where no irrigation water is available.

26. Although the farm population no longer is increasing, the population did increase substantially after agricultural expansion ceased. The present farm population is rather dense. This is one of the main reasons why the farms are small in size. Because the farms are small and the crop yields are restricted by inadequate water supplies, the farm incomes are substandard. The unsatisfactory situation in agriculture is reflected in most of the nonagricultural enterprises and incomes as the economy of the area is based on agriculture.

Water Resources Available for Development

27. Previous basin-type investigations of the entire Bear River drainage basin showed that new and supplemental water supplies for eastern Cache Valley could be provided by further development of local water resources more practicably than by construction of works to utilize more distant sources of water. The main water resources available for further development in eastern Cache Valley are the streams flowing from the mountains on the east and ground water.

28. Excepting the water in the artesian basin mentioned in paragraph 9, ground water is not available in sufficient quantity and suitable location to afford development of any substantial water supplies. The small quantities available can be developed privately. The artesian basin undoubtedly could be developed further. Years of study and observation, however, would be required to estimate with accuracy the development potentialities of this resource or the full effect that greater drafts of water would have on the existing artesian supplies. Further development of artesian water probably should proceed on an experimental basis, with State, county, and local organizations providing administrative direction. Such a program also could include drainage, reclamation, and controlled irrigation of presently waterlogged land overlying or adjacent to the artesian basin. Drainage and reclamation of such lands probably would

result in an increase in the irrigation water requirement at least equal to the additional supply obtainable through further development of the artesian basin. Thus, although the artesian basin is a potential source of additional water, it is considered neither a practicable nor sufficient source for meeting the needs of eastern Cache Valley in general.

29. The base summer flows of the surface streams now are fully appropriated and used during the irrigation season. Consequently, development of additional surface water involves storage of surplus flows that occur during the nonirrigation and spring runoff season. Storage sites exist on practically all of the streams but development of most of the sites would not be practicable because of high costs.

Conclusions

72. Insufficient irrigation water and inadequate drainage of some farmland are the principal factors retarding further agricultural and economic development of eastern Cache Valley. The East Cache project offers the best means of providing additional water for irrigation. Project drainage facilities would prevent waterlogging of land that might result from increased irrigation and also would improve some land now inadequately drained. The project could provide needed supplemental municipal water at a cost less than that of any other means of providing an equivalent supply.

73. The project has engineering feasibility and is justified economically, as evidenced by its benefit-cost ratio of 1.8 to 1. No unusual difficulties are anticipated in organizing project water users, obtaining repayment contracts, and constructing the project. Adequate water rights for the project could be obtained in accordance with water laws of Idaho and Utah. The project would not interfere with any existing development nor impair any potentialities for further resource development beyond the scope of the project.

74. Municipal water costs of the project could be repaid with interest at 2.5 per cent over a period of 50 years. Irrigators could repay 22 per cent of the irrigation costs over a like period. Although the project is economically justified, it would require repayment assistance not provided for by present Federal reclamation Law.

Recommendations

75. It is recommended that:

(1) The East Cache project report be held in abeyance until such time as the type of repayment assistance required by the project is provided by law and the policy of this Department; and

(2) The report be made available to interested State and Federal agencies and local interests.

L I T T L E B E A R P R O J E C T

U T A H

RECONNAISSANCE REPORT

MAY 1956

Excerpts from Report

Prepared by Bureau of Reclamation
Region 4, Salt Lake City, Utah

To: Regional Director, Salt Lake City, Utah

From: Area Engineer

Subject: Reconnaissance Report--Little Bear Project, Utah

SUMMARY--LITTLE BEAR PROJECT

LOCATION: Southern Cache Valley in Northern Utah, Bear River Basin.

PLAN

The Hardware Ranch Reservoir would be built to a capacity of 26,000 acre-feet on Blacksmith Fork. Water released from the reservoir would flow in Blacksmith Fork 10 miles to the existing forebay of the Utah Power and Light Company, passing en route through the Hyrum City powerplant. At the forebay project water would be diverted into the potential Blacksmith-Avon Canal that would extend west and south 11 miles to the East Fork of Little Bear River. The canal would serve lands along its course and would deliver irrigation water to the East Fork for distribution through the existing Paradise Canal and the potential Little Bear Canal that would head immediately below the confluence of the East and South Forks of Little Bear River and extend northwest 28 miles.

The Providence Canal would branch from the Blacksmith-Avon Canal 3 miles below its head at the mouth of Blacksmith Fork Canyon and would extend north 10 miles to Logan River. Water conveyed by the canal would be used directly for irrigation and by exchange for municipal use at Logan and River Heights and for irrigation above the canal.

The Porcupine Reservoir of 10,500-acre-foot capacity would be constructed on the East Fork of Little Bear River. Water would be released from the reservoir into the East Fork and distributed through the Paradise and Little Bear Canals before mentioned and through the Jackson ditch diverting from the East Fork. The Jackson ditch would be enlarged and extended 6 miles to irrigate land above the Blacksmith-

Avon Canal.

Laterals would be constructed as needed to distribute irrigation water to full and supplemental service lands. Surface and sub-surface drainage also would be provided.

IRRIGABLE ACREAGE (Acres)

Full service land	9,670
Supplemental service land	3,790
Total	13,460

PRINCIPAL AGRICULTURAL PRODUCTION

Crops--Alfalfa, small grains, pasture, peaches, apricots, apples, sugar beets, canning peas, canning corn, and canning beans.
Livestock--Dairy cows with some sheep and beef cattle.

WATER SUPPLY (average acre-feet annually)

Source	
Storage	28,700
Direct flow	8,300
Total	37,000
Use	
Irrigation	35,000
Municipal	2,000
Total	37,000

GENERAL DISCUSSIONS

Present Development

Population and communities

The portion of Cache Valley directly affected by the Little Bear project has a population of about 22,600. Logan, the principal town and county seat, had a 1950 population of 16,832. Other communities in the area and their 1950 populations include River Heights (900), Providence (1,055), Hyrum (1,704), Paradise (401), Avon (123), Wellsville (1,241), and Mendon (369).

Industry

The economy of the project area is based mainly on agriculture with income from dairy products providing the major source of livelihood. Manufacturing consists mainly of processing of agricultural products. The largest processing plants are a vegetable cannery at Hyrum and milk condenseries at Hyrum and Wellsville. Some construction activities along with the usual variety of supply and service industries support the remaining population.

Utilities and services

The project area is favorably located with respect to markets and transportation facilities. Markets in nearby Ogden and Salt Lake City provide an excellent outlet for agricultural products not required for local consumption. Transportation service to these points and others in Idaho and Wyoming and also within the project area is provided by the Union Pacific Railroad and by hard surfaced Federal, State, and county highways. Other utility services are very good. Electric power supplies are reliable and otherwise adequate. Municipal water systems provide satisfactory distribution of culinary water, but the supplies in some instances are insufficient for normal growth.

Irrigation development

Irrigation water is diverted from the various streams in the Little Bear project area and is conveyed to the farms by canal systems owned and operated by approximately eight nonprofit mutual irrigation companies organized by farmers using the water. Approximately 12,000 acres of land are presently irrigated by these companies with the annual shortages varying considerably between river systems. Most of the development to date has consisted of the construction of canals and diversion dams, without storage facilities, and within the financial ability of individuals and organized groups.

The Hyrum Federal reclamation project operates in the vicinity of the project area. It was constructed in 1934 and 1935 to provide additional water to lands in southern Cache Valley. The Hyrum Reservoir

on Little Bear River, the principal project feature, has an active storage capacity of 15,280 acre-feet. The water is distributed directly to lands below the reservoir and, by exchange, to some lands above the reservoir.

Hydroelectric development

Six existing hydroelectric powerplants are in the vicinity of the project area. By far the largest is the Utah Power and Light Company's 30,000-kilowatt Cutler plant on Bear River in the canyon forming the outlet to Cache Valley. A dam in the canyon creates an effective head of 123 feet and provides 17,000 acre-feet of storage capacity. Three small run-of-the-river powerplants are located on Logan River and two are on Blacksmith Fork. Data relating to the six plants are summarized below.

Data on existing hydroelectric plants

Name of powerplant	Owner	Stream	Installed capacity (kilowatts)	Static head (feet)
Cutler	Utah Power and Light Co.	Bear River	30,000	127
Logan Municipal	Logan City	Logan River	1,400	90
Logan	Utah Power and Light Co.	Logan River	2,000	213
Utah State	State of Utah	Logan River	450	35
Hyrum Municipal	Hyrum City	Blacksmith Fork	400	90
Hyrum	Utah Power and Light Co.	Blacksmith Fork	2,000	256

Needs and Problems of the Area

Development of a secure and stable irrigation water supply through the provision of adequate storage facilities at a reasonable cost to the water users is one of the greatest needs of the Little Bear Project area. The base summer flows of the streams are now fully appropriated and used. With the irrigators dependent upon the natural flow of the streams, crop failures are common during years of low runoff and low yields are prevalent in some areas, even in normal years. Because of the inadequately developed irrigation water supplies, large areas of arable land are being dry-farmed and produce only a small part of their potential. Yet large quantities of water discharge from the area unused for irrigation. Irrigation expansion is necessary to stabilize the production of crops to support the local agricultural enterprises, to provide for normal growth, to increase incomes in order that farmers may improve their living standards, and to otherwise provide economic opportunities for many of the young people in the area.

Landowners have shown considerable interest in developing the water resources in the area for irrigation and municipal purposes. Local water users' groups have conducted some investigations privately and with State

assistance but have been financially unable to make the type of studies required to determine the most advantageous development. Appointed members of water users' groups have contacted representatives of the Bureau of Reclamation several times for information during their private investigations and have expressed the desire to have the Bureau investigate the potential water and agricultural resources in the area.

Additional municipal water for Logan and River Heights is presently required to permit continued normal growth of these communities.

PROJECT APPRAISAL

The plan of development appraised in this chapter has evolved from a study of the relationships between the available land and water resources and the physical and economic factors related to their development. A general flow-line description of the project plan is given in Chapter I. The general location of project features and land areas is shown on the frontispiece map. This chapter covers the physical and economic appraisal of the tentatively selected plan of development.

Project Works and Costs

Preliminary estimating designs of reconnaissance scope, based on typical structures that have been successfully constructed, operated, and maintained over many years, were made of the required project works. Consideration was given to terrain and location, required capacities, geologic conditions, accessibility, and availability of suitable construction materials. No unusual construction problems are anticipated. The available engineering data are suitable for the purpose of the appraisal covered in this report but would not be adequate for preparation of construction designs and estimates. Structural features planned for the project are described briefly in the following paragraphs.

Hardware Ranch Dam and Reservoir

Hardware Ranch Reservoir would be formed on Blacksmith Fork at a point about 14 miles east of the town of Hyrum. The dam would be an earth-fill structure 165 feet high above streambed and 1,140 feet long at its crest. The spillway, located on the south abutment, would be a shaft-type structure with an uncontrolled morning glory crest. It would have a capacity of about 6,000 second-feet. The reservoir would have an active capacity of 25,000 acre-feet, with a dead storage capacity of 1,000 acre-feet for silt deposition and fish and wildlife conservation.

Geologic studies included the drilling of deep holes and a field inspection. These studies indicated that the site would be suitable for the type of dam contemplated, that satisfactory construction materials would be available within a reasonable hauling distance, and that the reservoir and dam site would be sufficiently watertight for the storage development as planned.

Blacksmith-Avon Canal

The Blacksmith-Avon Canal would head at the forebay of the existing Utah Power and Light Company Reservoir which is located about 9 miles downstream from the potential Hardware Ranch Reservoir. The canal would extend west about 3 miles to the mouth of Blacksmith Fork Canyon and then south approximately 8 miles to the East Fork of Little Bear River. The canal would have an initial capacity of 140 second-feet with the first 2.5 miles, that would be located on the steep slope of the canyon wall, being of reinforced concrete pipe. The open section of the canal below the Providence Canal turnout would have an initial capacity of 105 second-feet.

Porcupine Dam and Reservoir

Porcupine Reservoir would be formed on the East Fork of Little Bear River at a point about 4 miles east of the town of Avon. The dam would be an earthfill structure 155 feet high above streambed and 650 feet long at its crest. The spillway, located on the north abutment, would be an open chute structure with uncontrolled side channel crest. It would have a capacity of about 5,400 second-feet. The reservoir would have an active capacity of 10,000 acre-feet and an inactive capacity of 500 acre-feet for silt deposition and fish and wildlife conservation.

Geologic data were obtained from deep drill holes and field inspection. These data indicate that the site would be suitable for the type of dam contemplated, that satisfactory construction materials would be available within a reasonable hauling distance, and that the reservoir and dam site would be sufficiently watertight for storage development as planned.

Little Bear Canal

The Little Bear Canal would head at a diversion dam on the Little Bear River immediately below the confluence of the South and East Forks of Little Bear River. It would extend northwest about 28 miles to its terminus some 3 miles north of Mendon. The canal would have an initial capacity of 125 second-feet.

Providence Canal

The Providence Canal would divert from the Blacksmith-Avon Canal at the mouth of Blacksmith Fork Canyon. It would convey water north approximately 10 miles to Logan River, siphoning across Blacksmith Fork. The canal would have an initial capacity of 35 second-feet.

Jackson ditch enlargement and extension

The existing Jackson ditch would be extended in a northerly direction for about 6 miles. The initial capacity of the existing section of the ditch would be enlarged from 4 second-feet to 15 second-feet.

Laterals and drains

Laterals and drains were not designed for the project. Costs were estimated from general data on average costs for serving similar lands of other projects.

Project irrigation demands

Demands on project water supply to supplement presently irrigated lands constitute only about 10 per cent of the total project demands and are limited to two comparatively small areas: (1) lands now served from Smart ditch, Spring Creek, or Garr Springs in the Providence Bench area and (2) Paradise Irrigation Company lands. There are little or no data from which to determine the needs for supplemental irrigation in the Providence Bench area. It has been conservatively estimated by water users and irrigation company officials, however, that the average supplemental water supply needed for all inadequately irrigated arable lands in the area would be about one-third of the requirement for a full supply or 1,600 acre-feet annually. Supplemental requirements for the Paradise Irrigation Company lands have been estimated by the water users and officials at 2,500 acre-feet annually. This amount represents anticipated subscriptions by the water users. Other irrigation companies in the South Cache area have not expressed interest in supplemental irrigation supplies as they now suffer only small occasional shortages.

Municipal water demands

Municipalities to participate in the subscription of project water for municipal use will be Logan and the town of River Heights.

Municipal water for Logan is now supplied from a spring adjacent to Logan River. The water is conveyed to Logan through a pipeline recently enlarged to a capacity of 19 second-feet. The flow of the spring and the capacity of the pipeline are sufficient to meet all future anticipated municipal requirements. In low runoff years, however, water has to be bypassed to supply prior rights and the remaining water is insufficient to meet the needs of the city's growing population. Records of Logan's culinary diversions show a mean daily consumption of 220 gallons per capita. By applying this average consumption rate and the monthly variation as determined from the record, an annual requirement on a monthly basis was determined for a population of 25,500 anticipated by the year 1975. To meet the requirement in dry years such as 1934, a supplemental municipal water supply of 1,700 acre-feet annually would be required. With project development this supply would be delivered to Logan River and made available to Logan through exchange agreements with downstream irrigation companies.

Ground water, made available from pump wells, is presently used as the culinary water supply for the town of River Heights. This area has recently become a popular residential district and as a result water pressures developed in the present system are no longer adequate. The population of the town has increased from 288 in 1940 to more than 800

at present time. Local officials have indicated that they would abandon their present system in favor of one offering more dependability and related advantages. They have expressed a desire to participate in the project supply to the extent of 1 second-foot during the irrigation season. According to the present plan, this supply would be furnished them on an exchange basis from a spring adjacent to Spring Creek. Service for River Heights, however, is only tentatively included in the project pending further study of comparative costs of obtaining water from the project and from alternative sources.

Logan and River Heights would require a total diversion of 2,000 acre-feet annually from the project. Monthly studies indicate the demand for this water would be distributed over the irrigation season as shown below.

Month	Amount (acre-feet)
June	300
July	600
August	600
September	400
October	100
Total	2,000

PROGRAM OF FUTURE INVESTIGATIONS

The reconnaissance appraisal indicates that the Little Bear project would be justified economically on a benefit-cost comparison basis although water users would not be able to repay the full project costs. Detailed investigations for the project should be initiated as directed by, and in accordance with the wishes of, the State of Utah and local water users. Present indications are that the owners of the land in the area would favor an irrigation project and would be willing to convert from dry-farming to irrigation farming. If detailed investigations are undertaken, they would consist largely of preliminary engineering field surveys, detailed land classification, and refining of the engineering and economic studies made to date.

Only two significant problems are apparent at this time which would need to be resolved at an early date in the project investigation. One is the comparative economy of reservoir storage and of ground-water pumping to existing canals in exchange for surface supplies as means of developing part of the project water supply. The other is the extent to which the Mendon-Cache Junction area could be served by pumping from Cutler Reservoir and the relative economy of the pumping plan.

APPENDIX H

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